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Giacobini's Comet. (C. 1905.)

By THE REV. J. T. W. CLARIDGE, M.A., F.R.A.S.

THE year 1905 was far from being prolific in the discovery of comets. The only one that presented opportunities for interesting photographic study was that which was discovered by Giacobini on December 6, 1905, at Nice, with the great equatorial of that Observatory, which has an aperture of 76 cm.

No doubt the clear and still sky at that place must have contributed to his success. He is, and has been for a considerable time, a most diligent searcher in the cometary world, and the discovery of this one brings his record up to 10 at the end of 1905. In recognition of his labours in this field of research, the French Academy has awarded him the Valz Prize.

The following remarks are principally drawn from the photographic observations made at Flagstaff, Arizona, by Mr. J. C. Duncan. At that Observatory, altogether thirteen photographs were taken of the comet before perihelion passage, and one after—total 14. These show the growth of the comet from a bare nucleus to the development of the tail, 10° in length, and follow it after this till the time of exposure was too short to register any detail.

It may be noticed that the only exposure after perihelion passage was made by the use of a 5-inch Brashear photographic lens of 35 inches focal length. Mr. Duncan remarks that it was a matter of regret that this instrument, which has done such excellent work in stellar photography, was not earlier employed on the comet. In the other 13 photographs, the lens used was a Roettger portrait lens of $6\frac{3}{4}$ inches aperture and 29 inches focal length. This gave on the whole a fair definition over a field of 4 degrees radius, and as the comet's tail was in several instances much longer than this, the result was that its image was occasionally lost in those parts of the plate which are blurred by aberration.

In the accompanying figure, which has been drawn somewhat roughly and exaggerated from the elements computed of the comet, the circle represents the earth's orbit, and the small one in the centre, the sun. The letter E marks the position of the earth at the different dates in its orbit. The positions of the comet in its orbit are similarly shown. The longitude of its perihelion is given as 307° 17′ for January 16, 1906, and its distance calculated at 0.2154 of the earth's distance. This works out at nearly 20,000,000 miles.

The inclination of its orbit is 44° 39′. The perihelion distance being comparatively so small rendered the comet, as seen from the earth, unfavourable for any photographic observations till it drew away from the sun.

On the night following its discovery, a photograph was taken at the Yerkes Observatory, but not much detail could be registered. The trace of a tail of 0.5° in length was just discernible then, which gradually developed in a striking manner as the comet swiftly pursued its journey. The first photograph at Flagstaff was taken on December 14, 1905, after an exposure of 75 minutes, and in bright moonlight. This shows a faint but well-defined nucleus surrounded by a somewhat diffuse, though distinct, nebulosity, but with no indication of a tail. Probably, had the Brashear lens been used instead of the Roettger, more detail would have been marked. However, a week later, on the 22nd (Plate 1), the tail was clearly observed on the plate, measuring 25 inches in length. Fortunately, the moon, being past the quarter, offered very little obstruction to the seeing. The photograph, of 54 minutes' exposure, shows the nucleus to be well defined.

A week later still, on the 29th, with the same time of exposure as the preceding, the tail (as can be seen

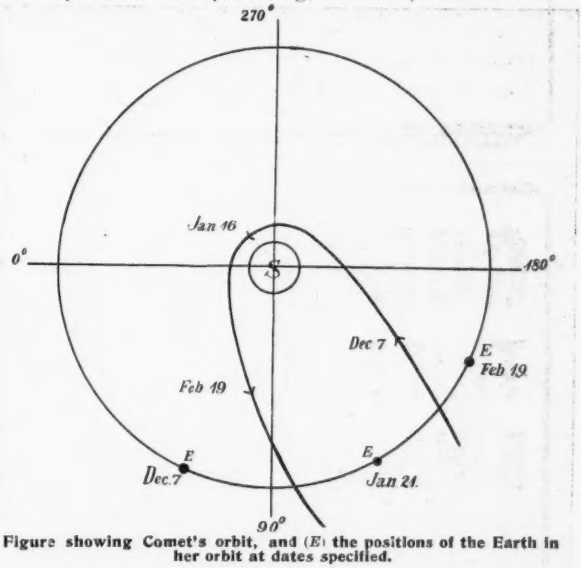


Figure showing Comet's orbit, and (E) the positions of the Earth in her orbit at dates specified.

in the plate No. 2) has wonderfully developed, showing an immense amount of detail, and is without doubt the most remarkable of the entire series. It will be noticed in the plate that the head of the comet was of an elliptical shape, 11″ long and 9″ wide, with a large nucleus and considerable coma. This picture was the only one showing the greatest size of the head. Two tails, one more than 2° long, and made up of at least four distinct streamers of a thread-like structure, with a great deal of nebulosity surrounding them, were developed. The streamers on opposite sides appear divergent, until they are about 20″ apart, where they fade away on the plate. To the north of the primary tail, and making an angle of about 20° with it, may be seen a kind of sharp and somewhat bushy-pointed appendage, forming a secondary tail of about 20″ long, much brighter on the side nearer the primary extension. The general appearance is suggestive of a

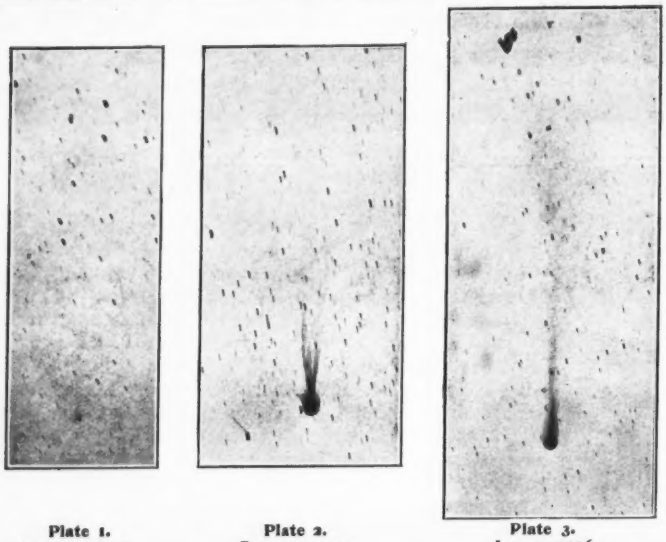


Plate 1. Dec. 22, 1905. Plate 2. Dec. 29, 1905. Plate 3. Jan. 1, 1906.

Three Photographs of Comet C 1905 (Giacobini) taken at Flagstaff, Arizona (J. C. Duncan).

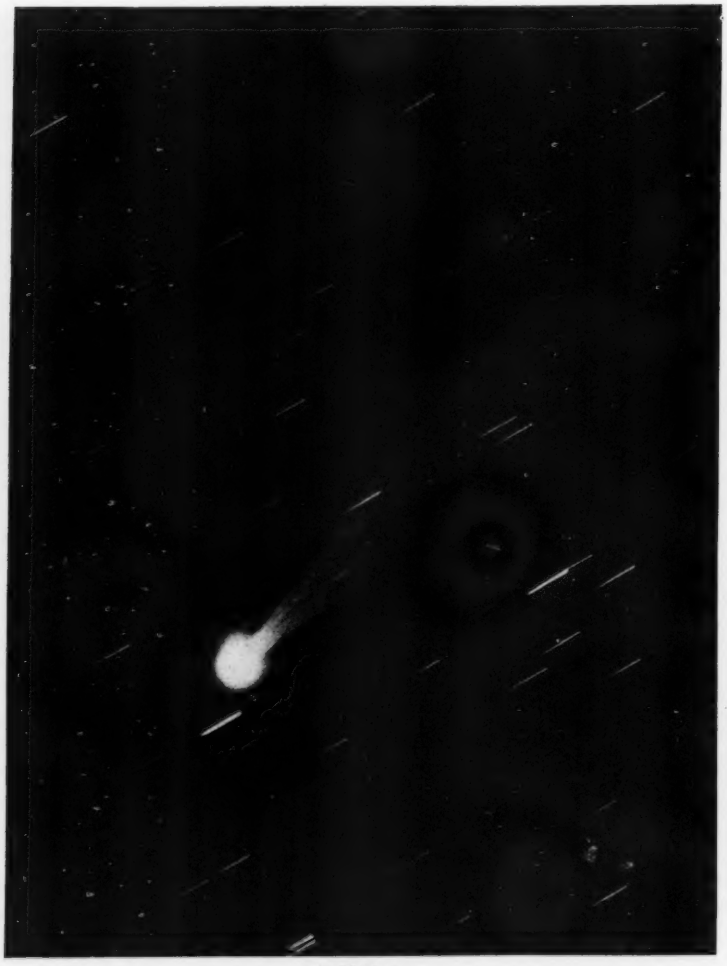


Plate 4.

Photograph taken at the Yerkes Observatory by Prof. Barnard, Dec. 29, 1905, 23 h. 20] m. (G.M.T.). (Exposure, 1 hr. 38 min.).

hollow and translucid cylinder, with an outside slightly convex, and of sensible thickness. The photograph exhibits very well this singular convexity in the structure of this comet's tail, and so it appears to possess a character without precedent till now excepted.

Plate 4, which was taken at the Yerkes Observatory on the same date, after an exposure of 1 hour 38 minutes, shows a similar complex structure. Professor Barnard says in his description of it: "Starting from the nucleus, several fine threads spread out towards the back, forming angles varying approximately from 15° to 30° from the principal axis of the tail. On the south side, at about 1° behind the head, there is found a large diffused ray in a line exteriorly under a small angle. The total length of the tail is about $4\frac{1}{2}$°."

On January 1, 1906 (see Plate 3), after an exposure (the sixth at Flagstaff) of 40 minutes, the comet had undergone considerable change, since nothing corresponding to the secondary tail of December 29 could be seen. The primary was at this time 5° long. When the tenth plate, taken on January 7, 1906, was examined, the comet was found to have three tails, all very faint. This was probably due to the fact that the exposure was too short, and the comet being at a low altitude. The middle tail was of 6° in length, the others about 2°. Near the head a dark rift was visible in the south-preceding tail. The central tail had a length on this night of about 1,800,000 miles. From this date till its gradual disappearance, the comet was travelling at an enormous speed, and was lost to view to the south of the Pleiades, as a telescope object, at the beginning of March, its distance from the earth towards the 20th of that month being upwards of 170 millions of miles. Among the interesting notes made of the comet may be mentioned its motion, which was perceptible in ten minutes, thus pointing clearly to its enormous speed through space. Unlike the retrograde motion of Halley's comet, which will, it is anticipated, be a resplendent object in the northern sky in 1910. Giacobini's was direct, or in the order of the signs. From the distinctive character of the comet's changes, it would appear that on no two dates did it present the same appearance, unless it were at the end of the tail. Like Brooks' comet (1893), the head seems to have advanced along its orbit, leaving the tail not quite in the same position angle. The thirteen exposures made at Flagstaff, before perihelion passage, were made in the hour preceding dawn, while the comet was at a low altitude. This will explain the star trails, and is due to the fact that the absorption of the star's light by the atmosphere at the beginning of the exposure was much greater than at the end.

XUM

Flippers and Fins.

By R. LYDEKKER.

IN popular zoology a sharp distinction is drawn, as a rule, between flippers or paddles, such as those of a whale or a porpoise, on the one hand, and the fins of fishes on the other. It is true, indeed, that the two terms are not exactly on all fours, owing to the fact that under the common title of fins are included not only the two pairs of these organs which correspond with the limbs of the higher animals, but likewise the unpaired back-fin and belly-fin. Again, a certain amount of confusion may arise in this connection from the fact that certain members of the cetacean order are commonly known among fishermen as fin-whales. This designation has, however, nothing whatever to do with their flippers, but refers solely to the fact that these whales are furnished with a short back-fin.

Restricting, then, for the moment the signification of the term fin to the paired appendages of fishes, we find that popular zoology is in this instance perfectly right in drawing a sharp distinction between flippers and fins. The difference between these two organs is indeed one of an extremely deep-seated and fundamental nature. For whereas the fins of fishes are primitive organs, originally developed from folds of skin running along the two sides of the body in the ancestors of the vertebrates, flippers, or paddles, are secondary modifications from limbs constructed for progression on land. In other words, fins are the old original type of limbs characteristic of animals which have been aquatic in their habits from the very beginning; while flippers, on the contrary, although admirably suited to their purpose, are really a kind of make-shift structure evolved and gradually perfected for swimming by creatures whose ancestors were inhabitants of the dry land. Flippers are, in fact, essentially adaptive modifications of pre-existing structures serving the purposes of locomotion, whereas fins form the original and primitive type of locomotor organs, so far at least as vertebrates are concerned.

Of course, it will be open to anyone to ask the question, why flippers are not to be regarded as directly evolved from fins? One answer to this very natural question is that flippers, as shown by their internal structure, are specialised (or, in one sense, degenerate) modifications of hands and feet, which, of course, would not have been the case had they been evolved directly from fins. Again, all animals that possess flippers are air-breathers, which have to come to the surface of the water periodically for the purpose of respiration; and in this case also it is perfectly obvious that if these creatures were the direct descendants of fishes, they would have retained gills for breathing in water instead of having developed lungs.

Having settled, then, the all-important distinction between flippers and fins, we may proceed to consider some of the chief structural types presented by the former. It may be mentioned, however, as a somewhat singular circumstance, that while in some animals furnished with flippers, development has been concentrated on the front pair, with the complete disappearance of the hind ones, in other cases both pairs have undergone special development. Again, while in some groups in which both pairs persist, the front flippers are much larger than the hind pair, in other instances there is an equality in point of size between the two. Doubtless there are good and sufficient reasons for these important differences; and it seems evident that the disappearances or diminished size of the hind pair is co-related with the degree of development of the tail-fin. In whales and porpoises, for example, the huge laterally expanded tail-fin, which acts like a screw-propeller, renders hind-flippers superfluous. Again, in the case of the two extinct groups of marine reptiles, respectively known as ichthyosaurs and plesiosaurs, there is evidence to show that in the former the tail was furnished with a powerful fin, while in the latter, if such a fin was present at all, it was probably much smaller.

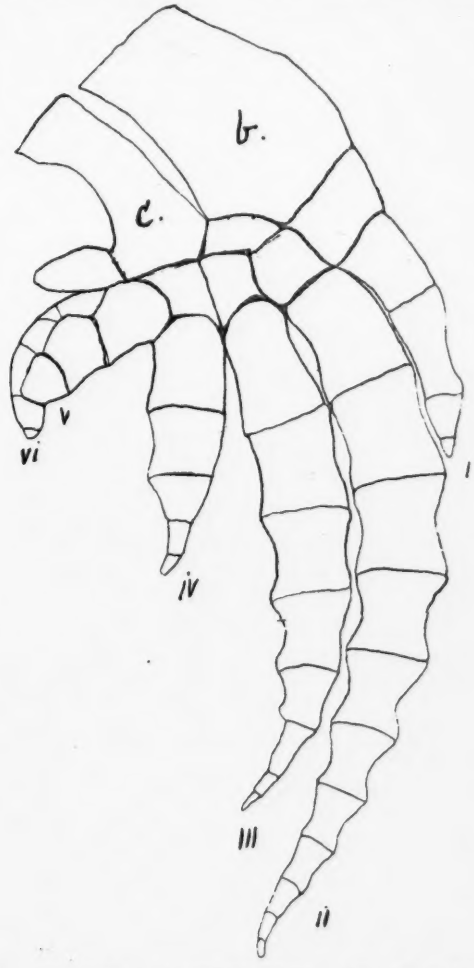


Fig. 1.—The Skeleton of a Whale's Flipper. (After Symington.) *b*, **Radius.** *c*, **Ulna. The humerus (*a* in the other figures) is not shown.**

Hence, perhaps, the reason why the hind-flippers of the ichthyosaurs are much smaller than the front ones, while in the plesiosaurs the two are of approximately equal dimensions.

Among mammals, the simplest type of flipper is presented by the seals and walruses. In fact, their flippers may be regarded merely as webbed and unusually elongated feet; the number of toes in each always being the typical five, while in no case is there any increase above the normal as regards the joints entering into their formation. Both pairs of flippers are well developed, but, in swimming at any rate, the hind pair is directed backwards parallel to the short tail, so as to

form a propelling organ analogous to the screw of a steamer. Despite the comparatively slight modification it has undergone, the seal's flipper is perfectly and completely adapted to its purpose, and we cannot imagine any further modification of its structure by evolution, which would lead to greater efficiency.

An altogether different and more advanced modification is presented by the flippers of the whales and porpoises, or cetaceans, as they are collectively designated. In this group, as already mentioned, all external traces of the hind-limbs have completely disappeared; while the front-flippers show no external division into fingers, and have (at least after birth) completely lost the claws, or nails, which are well developed in seals and walruses. When the skin of a whale's flipper is removed and the bones of the interior exposed to view (Fig. 1), a very abnormal state of affairs is revealed. Two or three of the toes are, for instance, much more developed than the rest, and may be practically the only ones remaining. On the other hand, as in the specimen represented in the illustration, there may be more than the normal

Fig. 2.—Bones of a Turtle's Flipper.

Fig. 3.—Skeleton of the Flipper of an extinct Sea-Serpent, or Mosasaur.

five toes, while in the two toes attaining the maximum development, there is a great increase in the number of constituent joints above the three characteristics of mammals generally. This redundancy of development is, as will be shown later, paralleled among reptiles. It may be added that whales apparently pronel themselves chiefly by means of the enormous horizontally expanded tail-fin, or "flukes"; the flippers, despite the great length they attain in the hump-backed species, probably acting in the main as balancers.

The sea-cows (manatis and dugongs) resemble whales in having only the front pair of flippers, which show no external trace of division into toes. Vestiges of nails may, however, persist; while when the interior is examined it is found that the five toes are retained, while there is no increase in the number of their constituent joints above the normal three. To all appearance the flipper of a sea-cow is just as efficient an instrument as that of a whale, and yet there is this marvellous difference in their structure. If we ask why this is, no man can give the answer.

Differences paralleling those occurring in mammals are noticeable in the flippers of reptiles. In the living marine turtles, for example, we find a type of flipper (Fig. 2) corresponding to a considerable degree with that of a seal, although it is more completely enclosed in a common external covering. The resemblance is exemplified by the fact that one or two claws are retained, as well as by the retention in the front pair of the normal five toes, and likewise by the absence of any augmentation in the number of the joints entering into their composition, which is, however, as in reptiles generally, higher than in mammals. From the large size of their front flippers relatively to the hind pair, coupled with the absence of a tail-fin, it would seem evident that turtles swim chiefly by means of the former organs.

Among marine reptiles of a more normal type, that is to say, without the peculiar shell, an extinct group known either as mosasaurs or as sea-serpents, furnishes us with another example of a comparatively little modified type of flipper (Fig. 3). In these creatures, of which some attained a length of thirty or forty feet, there are two pairs of flippers; the front ones not being greatly larger than the hind pair. In both pairs there are the usual five toes, which may have carried claws or nails, and are composed of only the normal number of joints. These extinct sea-serpents doubtless propelled themselves along the surface of the old Chalk seas by working both pairs of paddles with equal vigour and strength.

A more complex type of paddle (Fig. 4) is presented by another group of extinct marine reptiles, the aforesaid plesiosaurs, many of which were likewise of gigantic dimensions, rivalling, indeed, in this respect the modern whales, by which they were destined to be ultimately replaced. In neither the fore or the hind flippers of these strange creatures, which are approximately equal in size, is there any increase or decrease above or below the normal number of five toes. On the other hand, it will be noticed that the number of bones entering into the composition of the individual toes (or digits, as it is often convenient to call them) is very greatly augmented. As some of these flippers were nearly six feet in length, they must have formed propelling organs of enormous power, so that their owners probably rushed through the sea with a speed approaching that of a torpedo-boat.

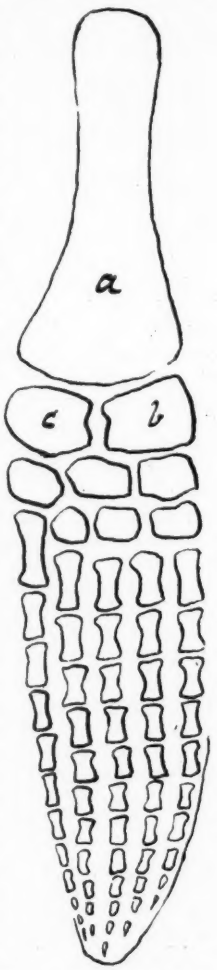


Fig. 4.—The Bones of the Flipper of a Plesiosaur, showing the abnormal number of toe-bones.

The culminating type of complexity as regards the structure of the flipper is, however, presented by the fish-lizards, or ichthyosaurs, which were the contemporaries of the plesiosaurs, and their rivals in point of size. In all these reptiles, as shown in Fig. 5, while the toe-bones are enormously increased in number, they have also lost the elongated form characteristic of those of all other animals, and have assumed a polygonal contour, so that collectively they form a kind of mosaic,

or pavement-like structure. In some species, as in the specimen shown on the left side of the illustration, there are three main longitudinal rows of toe-bones in these wonderful and uniquely-made paddles, with a supplementary row on the hinder border. In other kinds, however, as shown in the right hand figure, the number of rows (that is to say, the number of toes) may be increased to six, or even more. Nothing comparable to this wonderfully elaborate bony structure is to be found elsewhere in the whole animal kingdom. As already mentioned, the hind-paddles are similar in structure to the front ones, but of much smaller size, in correlation, apparently, with the development of a powerful tail-fin.

No swimming reptile, either living or extinct, has followed the line of evolution set by the whales which has led to the loss of the hind-limbs.

The account of flippers having run to such a length leaves, unfortunately, but little space for the consideration of fins. Palæontology and embryology indicate that the earliest fishes carried a vertical fold of skin down the middle line of the back, and a pair of similar folds along the sides of the body, each supported by a series of parallel rods connected with the skeleton.

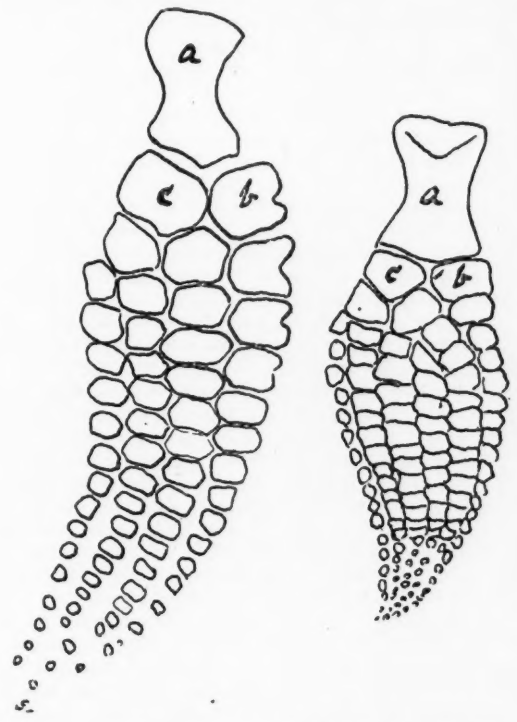


Fig. 5.—The Flippers of two species of Fish-Lizards, or Ichthyosaurs, showing the pavement-like structure formed by the toe-bones.

Owing to some cause or other, the back-fold became restricted to two portions of its length, now forming the dorsal fins; while the lateral folds were still further diminished, so that only two narrow paired portions eventually remained, these forming the front and hind, or pectoral and ventral fins. Originally these paired fins were supported by parallel rods, formed by the internal skeleton. The next step was the reduction of the supports to a single-jointed rod or axis, from which diverge cartilaginous fin rays. This type (Fig. 7) is now represented by the lung-fishes, but it also occurs in the early sharks and likewise in the forerunners of ordinary bony fishes. A further stage, shown in Fig. 6, is the reduction of the supporting cartilages to three (1, 2, 3,) or two short basal pieces, placed side by side, from which arise the cartilaginous rays. This type occurs in modern sharks and chimæras, and like-

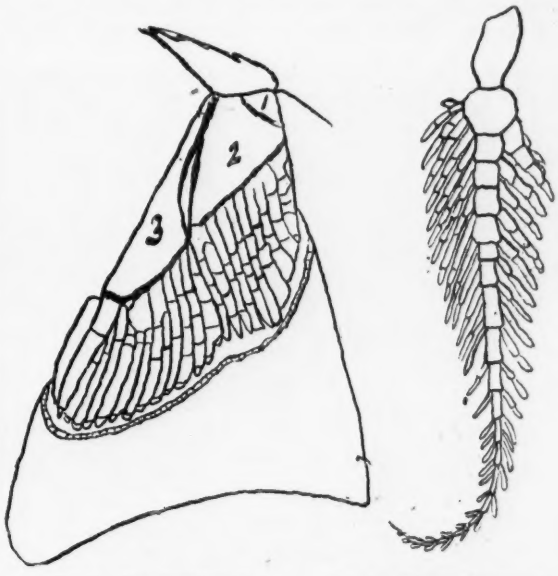


Fig. 6.—The Skeleton of a Shark's Fin.

Fig. 7.—The Cartilaginous Axis of the Fin of the Australian Lung-Fish.

wise in the enamel-scaled African fishes, known by the name of bichir (*Polypterus*). From the fringe-finned type, characteristic of the bichir, may easily be derived the fan-finned modification, distinction of the ordinary bony fishes of the present day, in which the supporting basal cartilages are small or rudimentary, while the cartilaginous rays of the fin itself have given place to horny rays formed from the skin instead of from the true internal skeleton.

To the Smithsonian Institution we are indebted for a copy of Part 3 of the third volume of the quarterly issue of the *Miscellaneous Collections*. In the first article Messrs. Dyar and Knub point out that in the British Museum *Monograph of the Culicidæ* Mr. Theobald is mistaken in his statement that some of the females of the Mosquitoes of the genus *Megarhinus* resemble the males in having five-jointed palpi. In all species there are only four joints to these organs in the female. The other papers include descriptions of new squirrels from Borneo and Sumatra by Mr. Marcus Lyon, a study of the venation of the wings of butterflies from the point of view of their evolution by Mr. T. J. Headlee, notes on various non-European species of the carp tribe by Mr. T. Gill, and a review of the North American volutes by Dr. A. H. Dall. It should be noticed that the genus *Leuciscus*, employed in Europe to denote the roach and dace, is used to replace the name *Squalius*; *Rutilus* being substituted for the dace group. American volutes are divisible into two groups, according as to whether the primitive shell, or protoconch, is at first shelly or membranous.

XUM

Earthquake Origins.

Professor T. J. J. See's Revival of the Explosive Theory.

FOR some years past the students of earthquakes have followed or accompanied Professor John Milne and the other observers of the new seismological school in the theory that the great as well as the small disturbances of the earth's crust are due to crumpling of the strata, due to insecurity of position or doubtful stability. Thus

Fig. 1.—The cloud of steam arising from Mt. Pelee.

a great mountain range, especially if in the neighbourhood of a coast line, and particularly if the sea in the neighbourhood of the coast is deep, may be regarded as a pile of strata which, owing to the enormous superincumbent weight, has a tendency to producing slipping or sliding of the strata. "Throughout the world," writes Professor John Milne in his classic work on "Seismology" (1898), "we find that seismic energy is most marked along the steeper flexures in the earth's crust; in localities where there is evidence of secular movement, and in mountains which are geologically new and where we have no reason for supposing that seismic movements have yet ceased." Professor Milne goes on to point out that at the chief seismic regions of the world, which are the west coast of South America, near Aconcagua, the Kurile Islands, the east coast of Japan, and the region north of the Sandwich Islands, there are slopes ranging from 1 in 20 to 1 in 30. He adds: "The conclusion derived from this is that if we find slopes of considerable length extending downwards beneath the ocean steeper than 1 in 35, at such places submarine earthquakes and their accompanying landslips may be expected. On the summit of these slopes, whether they terminate in a plateau or as a range of mountains, volcanic action is frequent, while the earthquakes originate on the lower portions of the face and at the base of these declivities. Districts where earthquakes, often followed by submarine disturbances, are most frequent are regions like the north-east portion of Japan and the South American coast between Valparaiso and Iquique. Here we have a double folding. The sea bed as it approaches the shore line, instead of rising gradually, sinks downward to form a trough parallel to the coast, after which it rises to culminate in mountain ranges. The South American trough which lies within fifty or sixty miles off the coast, like the Tuscarora deep off Japan, attains depths of over four thousand fathoms, and the bottoms of these double folds are well-known origins of earthquakes and sea waves."

Such, very briefly stated, is the tectonic theory, with which readers of "KNOWLEDGE" are for the most part familiar. Professor T. J. J. See, whose recent investigations on the rigidity of the earth are of first-class importance, has attacked this theory with considerable skill, and has returned to the far older hypothesis which suggests that earthquakes are caused by the waters of the earth's surface percolating the crust till they come in contact with molten rock and then produce steam explosions. His paper on "The Cause of Earthquakes, Mountain Formation, and Kindred Phenomena" has now been reprinted from the Proceedings of the American Philosophical Society.

His first proposition is that "the internal temperature of the earth is extremely high, with heated rocks quite near the surface, while the crust is fractured and leaky everywhere, and especially where the depth of the sea is greatest. The sea covers three-fourths of the earth's surface, and earthquakes are found to be most violent where the sea is deepest, and volcanoes most numerous on the adjacent shores." From this it is but a step to argue that the statement of these propositions leads naturally to the inference that the earthquakes are caused by the explosive power of steam. It remains for Professor See to show that this hypothesis more completely accounts for observed facts than the alternative one to which Professor Milne, Professor Ewing, Major de Montessus de Ballore, Dr. Agamennone, Herr Grablowitz, and the Japanese school of seismologists, Omori, Kato, and Nagaoka, subscribe more or less in unison. He does so by first pointing out defects in the

Fig. 2.—Vertical section perpendicular to the Andes and Andean trough drawn to natural scale.

tectonic theory. Even the steepest of the slopes which are given as instances of probable origins of tectonic disturbance are not steep enough to cause either slipping or fracture. Compare the slope postulated by Milne of 1 in 20 with the slope of Mount Cotopaxi for example.

Mount Cotopaxi has a slope of 30 degrees; but its rocks do not slip. Yet the slope here is ten times as great as that which is required by the Milne theory. "If we recall the smallness of the slopes from the great mountain ranges to the bed of the sea—it never exceeds that of our mountains on land, and is seldom as steep—and observe that the surrounding sea water would buoy up and resist any supposed sliding deposit, we shall find it difficult to believe that the theory is well founded. Such a deposit resisted by the surrounding water would slide with extreme slowness and settle quietly without any appreciable jar, and consequently no earthquake of importance could be produced in this way. . . . The forces which may shake an entire continent and send waves of compression and distortion through all the rocks between two oceans, and disturb the whole earth, are not produced by so small a cause as the slipping and bending of ledges of rock."

It is not possible within the space at our disposal to follow Professor See through the long and elaborate demonstration by which he seeks to prove that his theory of subterranean disturbances will account not only for earthquakes and volcanoes, but will also explain the formation of mountain ridges and plateaux, as well as the trench-like depressions in the sea parallel to coastal mountain ranges; and we can only present our readers with a summary of his general conclusions. Among these are—

(*a*) The theory that earthquakes are due to fracture and slipping of rocks is disproved by the great depth (ten to twenty miles) at which world-shaking earthquakes are found to originate, and by virtue of the fact that they come not from a point or line, but from an area.

(*b*) It follows that earthquakes must depend on explosive forces within or just under the earth's crust, and frequently spread over a considerable area, and the preponderance of disturbances in the sea and along the shores of continents shows that the forces depend in some way on sea water.

(*c*) That steam is the cause of volcanic eruptions is shown by the distribution of active volcanoes along the shores, and by the innumerable eruptions which take place in the depths of the ocean, whereas such vents always die out inland. And, moreover, by the fact that of the vapours emitted from volcances 999 parts in 1000 are estimated to be steam.

(*d*) When the subterranean steam pressure becomes great enough to shake the earth's crust it naturally moves at the nearest fault line where the rocks are broken; *but the movement observed is the result, not the ause, of the earthquake.*

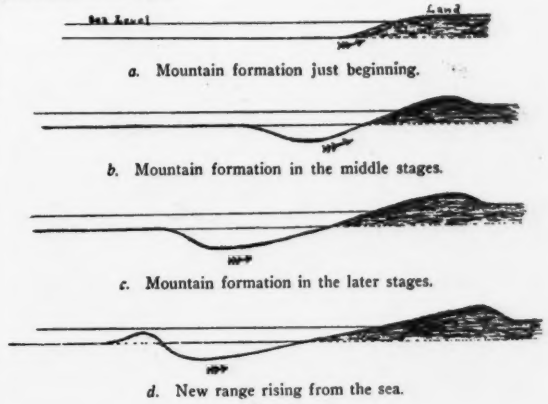
(*e*) Mountains in the interior of a dry country, as he Rocky Mountains in Colorado, exhibit no important movements, while those on the coast, like the Andes, are always heaving. The only countries which are free from earthquakes are the waterless deserts.*

We may conclude with recapitulating in brief summary the application of Professor See's eruptive lava theory to the formation of mountains and mountain ridges. According to this theory, the ocean percolating into the lava beneath the earth's crust forces up a mountain chain by gradually raising the coast line as the result of a series of steam upheavals. If the lava is forced towards the sea, a new ridge may be upheaved there; if towards the land, the coast or mountains are upraised. Parallel mountain chains are thus produced, and the sea at length drains out of the trench between them.

* The great New Madrid earthquake, affecting a region 300 miles in length in 1811 and 1812, is attributed by Professor See to the filtering through of the waters of the Mississipi Delta. It certainly could not be attributed to the slipping of mountainous strata. The centre of the violent Bengal-Assam earthquakes was under the Brahmaputra River where it spreads to a great width.

In other words, the action may be described as follows:

"The mountains are formed by the injection of steam-saturated lava under the coast, which breaks through the overlying surface rocks and gives rise to a ridge parallel to the sea.



a. Mountain formation just beginning.

b. Mountain formation in the middle stages.

c. Mountain formation in the later stages.

d. New range rising from the sea.

Fig. 3.

"By continually injecting the land with lava from under the bed of the sea, the coast is raised and the mountains upheaved, while at the same time the support of the sea bottom is undermined by the thinning out of the fluid substratum, and at intervals the bottom sinks down to restore stability." (See figs. 2 and 3.)

"The sea bottom does not subside without the lava under the crust being forced out into some other place, as into islands, submarine ridges or shores."

E. S. GREW.

The Bi-Centenary of Linnaeus.

THE bi-centenary celebrations of the birth of Linnæus, for which Swedish botanists have been making preparations during the last three years, will begin this month (May 23) at the University of Upsala. The 23rd of May is the veritable birthday of Linnæus, although for a number of years it was supposed—the founder of the Linnæan Society being among those who held the belief—that the date was May 24. The confusion arose from the fact that in the conversion of the calendar from old into new style, the King of Sweden, a prudent and philosophic monarch, decided to advance by easy stages and effected the alteration in leap years so as not to offend the prejudices of his subjects. The whole story of the mistake, which is a very curious one, is to be found in Mr. Dayton Jackson's article on Linnæus, in the Encyclopædia Britannica. It is, perhaps, worthy of remark that the Linnæan Society still holds its annual meeting not on May 23, but in accordance with its founder's charter, on May 24.

As no doubt is known to our botanical readers, the collections of Linnæus are now enshrined at Burlington House.

The Linnæan Society acquired them, though very ill able to afford the money, for £3,000. They consist of the collections of plants, manuscripts, books, and other related treasures, to which the widow of Sir James Smith (who survived him for more than half a century, and died an unchallenged centenarian) added several articles of curious and exceptional interest. The manuscripts are possibly the most intrinsically valuable part of the relics. Some, indeed a large number, remain untranslated to this day, for they are written in an illegible medley of Swedish and Latin, in a cursive script, rather like German handwriting; and it almost

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requires the skill of a palæographer to make them out. Five of them have been lent to the University of Upsala to grace the coming celebrations; and it is possible that they may be translated and published. The Linnæan Society has also struck a special copy of the Linnæan gold medal, which will be conveyed by its special repre-

The Linnæa Medal.

sentative, Mr. Carruthers, to Upsala, there to be presented to the University. By the courtesy of Mr. Dayton Jackson, of the Linnæan Society, to whom we are greatly indebted for the information in this brief article, we are enabled to reproduce a line engraving of the medal. The Society's ordinary medal has this year been awarded to Dr. Melchior Treub, of the Java Botanical Museum.

Practical Aerodynamics And the Theory of Aeroplanes.

By MAJOR B. BADEN-POWELL.

IV.

We have not yet done with the subject of air-pressures acting perpendicularly to a plane-surface. It was suggested in the last article that the exact amount of pressure varies with size, shape, and speed of progression of the plane.

As regards the size of the plane, the matter is not clearly decided. Hutton stated that large surfaces resist the air more in proportion than small ones. Von Loessl found that "small and large surfaces experienced resistances simply proportional to their sizes." In these experiments, surfaces varying in area from 0.0017 up to 2 square metres were used.

Langley tested plates of 6, 8, and 12 inches square, and found that the pressures on the latter were greater in proportion, yet he remarks: "I am not disposed, however, to consider this as a real effect due to an actual difference in the pressure per unit area on these planes," but rather "as discrepancies in the observations," but he adds "that there should be a real, though perhaps a small, difference between the pressure per unit area on planes of different sizes seems in fact quite probable."

In considering the shape of the surface, it has to be borne in mind that the pressure is not uniform over the whole surface, but is greatest towards the centre, and falls away rapidly towards the periphery. For this reason one might expect that when the periphery is great in proportion to the surface, as in a long oblong, the resistance would be less than when this is not the case, as with a circle.

Taking the figures from the experiments conducted for the Aëronautical Society in 1870 (though these had other objects), we see at two different pressures

Circle of 1 square foot area, pressure	3·1	4·26
Square of 1 square foot ,, ...	3·24	4·29
Oblong 4½ in. × 18 in. = 81 sq. in. = at rate of	3·96	5·04

Dr. Stanton mentions that, in his experiments, "the results for square plates appear to be identical with those for the circular plates." But he adds that when he came to test models of lattice form, the intensity of pressure was 25 per cent. higher than in the case of square plates. He also found that the mean pressure on a long, narrow rectangular plate was 60 per cent. greater than that on a circular one, and that the intensity increases as the ratio of length to width increases. Dr. Stanton tested a number of plates varying in their relative proportions from 1 : 1 to 50 : 1, and obtained a curve showing the varying pressures.

Mr. Dines also tried plates of oblong form, having sides 16 to 1 and 4 to 1, and the results agree with those given in Stanton's diagram. But Mr. R. E. Froude, in discussing Dr. Stanton's results, says; "This result seemed to him to be frankly incredible."

The reason for this, undoubtedly, is because the air becomes heaped up, forming a cushion over the plane, and that the air towards the edges flows off more easily.

Speed of progression of the plane may be of two kinds. It has already been said that if the speed of a plane moving at right angles be very considerable, that is, over 100 miles an hour, it is probable that pressure may not be in accordance with that developed at lower rates (Professor Greenhill, Brit. Assoc., 1883), but it is a matter of controversy which it is hardly necessary here to go into. If, on the other hand, we consider a surface moving in the direction of its plane, for instance, if a flat and level sheet of paper while falling be pushed forward horizontally, then we find that it will fall more slowly than if not progressing. This may be accounted for by supposing that, in falling, the air has to be pressed away from underneath, and has to find its way round to fill the vacuum which would otherwise be formed above. This takes time, but before the requisite time has elapsed, the plane has moved on, and has to deal with a fresh body of air. Langley made some interesting experiments on this with his "Plane-Dropper," and considered this a most important fact as affecting aërial machines, since it implies that by travelling at a very rapid rate we can obtain great lifting power. He compared the action to that of a skater who proceeds rapidly across thin ice—ordinarily unable to bear his weight—but which has not time to break under him. But this action also brings us to another category, for a plane progressing horizontally at the same time as it falls vertically is equivalent to a plane moving through the air at an inclination, which is an important subject to be considered in a later article.

In all these cases it has been usual to consider only the pressure on the exposed side of the plane. But with a thin, rigid plane, it is evident that when driven vertically against the air there will be a negative pressure or partial vacuum at the back. This opens up a most difficult and complex problem. Dr. Stanton has investigated this, and found that the negative pressure was greatest just behind the edges of the planes. The ratio of maximum pressure on the windward side to the pressure on the leeward side of a *circular* plate was found to be 2.1 to 1, whereas the ratio for a *rectangular* plate was 1.5 to 1. That is, the intensity of pressure on the leeward side of a rectangular plate is greater than that on circular or square plates.

This ratio, as determined by Dr. Stanton, for discs of 2 inches diameter, was precisely the same as that found by Mr. Dines in his experiments with a plate one foot square in a whisting tube.

Pinhole Photography of the Sun.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

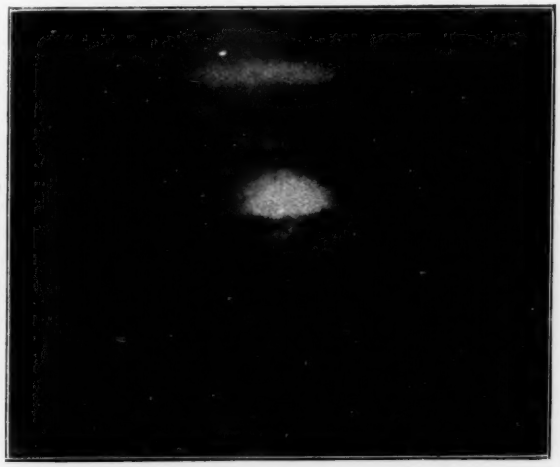
IN the year 1650 an English edition of Porta Giovanni Baptista's curious book on natural magic was published in London, and attracted as much attention as did the original edition when it first appeared, 35 years before, in Naples. Like most of the scientific books of that period it teemed with fables, and gave exact descriptions of monstrosities that could never have existed; but, at the same time, it faintly foreshadowed many of the discoveries of a later day.

Thus, in the chapters dealing with optics, it describes, or rather mentions without describing, "how, without a glass, or a representation of any other living thing, an image may be seen to hang in the air."

This evidently refers to a primitive form of camera obscura in which a minute hole took the place of the lens in the modern camera, and a pictured image of objects outside could be seen within the dark box or darkened room.

As there were then no means of fixing this image when projected on to paper, the discovery was looked upon as little more than a scientific toy, and when the day of the sensitive plate arrived, the glass lens gave images so much sharper than any pin-hole could do, that no one thought it worth while to revert to a primitive method.

The aim of the photographer of those days was to get a picture full of minute detail, one showing every hair on the head of a sitter, and every leaf on a tree, and it is only within the last few years that the greater beauty of broad effects in photography has come to be partially recognised. With this reaction the pictorial possibilities of a pin-hole in place of a lens have suggested themselves to several workers, and such excellent results have been obtained that it is strange that so simple a method should not be more generally used.



Pinhole Photograph of the Setting Sun, January, 4 p.m. Exposure ½ second.

In particular, it seems to have occurred to no one to make use of a pin-hole in photographing the sun, notwithstanding the fact that a minute hole in a card has long been used as an excellent substitute for smoked glass as a screen for the eye when looking at the sun. It is equally effective as a means of protecting a sensitive plate from the excessive action of direct solar rays, and there is probably no better way of taking a photograph of the sun breaking through banks of clouds. So much light is cut off by the narrow aperture that there is little risk of spoiling the plate, and the writer has even succeeded in making two exposures and getting duplicate images of the sun on different parts of the negative without the slightest trace of fogging.

Enlarged Pinhole Photograph of Partial Eclipse of Sun, August, 1905. Exposure $\frac{1}{25}$ second.

The construction of a pin-hole camera is of the simplest description; all that is necessary being a dark box with means for holding a sensitive plate upright at one end, and an opening in which is fixed a disc of metal foil pierced with a needle at the other.

A very satisfactory method is to unscrew the glass lenses from an ordinary camera and replace them by the pierced disc of blackened foil, which should be cut to such a size that it exactly fits the flanges of the lens.

The greatest care is required in making the pin-hole in the disc, since the smallest irregularities in the edges of the hole will cause light to be reflected and give a distorted image. The burr formed by the needle must be rubbed down with emery stone, and the hole examined from time to time with a magnifying glass to see that it is quite circular.

The smaller the opening, the sharper the definition of the picture, but the longer the exposure required. The size most suitable for general pictorial work is about $\frac{1}{58}$ inch, corresponding to No. 20 opening on a standard wire gauge. A disc with this size of pin-hole was used in taking the picture of the setting sun breaking through clouds (see Fig. 1), an exposure of half a second being given.

In photographing the sun unveiled by clouds it is better to use a still smaller opening (about $\frac{1}{50}$ inch or No. 25 on the standard wire gauge) with an exposure of about $\frac{1}{25}$ second. Photographs of the sun or moon taken without the use of a telescope are always disappointing, since they only appear of about the size of a pin's head upon the negative. Still the image obtained with a well-made pin-hole is quite sharp and will stand considerable enlargement, as is shown by the enlarged pin-hole photograph of the eclipse of the sun of August, 1905, taken by the present writer on the Belgian coast.

The Worshipful Company of Goldsmiths has made a donation of £10,000 to the Lawes Agricultural Trust (Rothamsted Experimental Station) to be devoted to research in connection with the soil, and to be known as the Goldsmiths' Company's Fund for Soil Investigation.

The Shape of Molecules.

By W. F. BADGLEY.

IT is now generally allowed that the shape of the molecules of the elements bears some close relation to the crystalline forms of their combinations, and Dr. Tutton has found that the angles of the crystals of each substance are identical, while they differ from those of all others, and it is no doubt owing to this difference of their molecular forms that some metals refuse to form alloys together, and other elements refuse to combine.

Also Messrs. Hadfield and Fleming have shown by their researches that there is some movement possible to the molecules of even the hardest of metals at their coldest; as, for instance, in the iron, with 20 per cent. nickel alloy, that is non-magnetic when made, becomes magnetic on cooling with liquid air, retains the property on return to ordinary temperature, and is found to be permanently expanded.

Further, it is allowed that the molecules at the surface of all substances are constantly being detached, some quickly, as water, others very slowly, as gold, but what governs the dispersion requires explanation, as substances act very differently under different circumstances. The molecules from the surface of a piece of gold pressed against a piece of lead disperse into the lead; this takes years, but they pass much faster than they do into air or water. The surface molecules of water disperse quickly into air, but refuse to enter oil. The molecules of common salt readily disperse in water, but refuse to enter air or most solids in any appreciable quantity.

Probably what happens in all cases of dispersion or solution is this—the surface molecules, being unconnected on one side and partially free from cohesion, are partly expanded from the crystalline shape, and the pressure of the surrounding molecules of air, fluid, or other substance has sufficient force to shoulder off these semi-detached molecules, and complete the separation. When separated, they are no longer crystalline. If elements, they are spheres, and if compounds, they assume some such shape as bubbles do when joined together, always arranging so as to be as nearly spherical as possible; never are they arranged in pancake form, like corks floating in a basin; the free behaviour of all fluids sufficiently proves this.

In speaking of osmosis, the word "pressure" is used as if the water was forced through the membrane into the solution. It is the other way about; it is the change of form and dispersion of the molecules of the solute that draws the water through the diaphragm. When the salt changes from the crystalline to the spherical shape, interspaces are formed between the molecules, and the water is drawn in to fill these; also the salt molecule is not settled comfortably, until it has found, for itself alone, an interspace among the water molecules; when all the salt molecules are surrounded with water molecules, the pressure, as it is called, ceases.

All the properties of matter point to this, that in the solid their molecules are of such form as to allow of close contact and cohesion, and in the liquid and gaseous states, that they are as nearly globular as their composition will allow, and that their dispersion depends, not on any antagonism among them (for that would imply a molecular force that there is nothing to originate), but merely on the pressure of the atmosphere, which obliges every molecule to seek some interspace, where it will be most free from pressure.

In solution and in vapour, the compound molecule floats with its heavier component downwards, and with a liquid or gaseous barrier round it. Anything that will break up this arrangement, as a glass rod or an electric current, will hasten chemical change between different substances in solution. A current of electricity sent through a solution (as shown by Mr. Whetham in some beautiful experiments) produces movement and change, driving the metallic component in one direction. The current passes with a rapidity comparable to that of light; the carrier takes hours to move an inch. The electricity passes in small charges, that go from molecule to molecule, giving the metallic component, on which alone it can act, a backward kick that sends it towards the next already vacant acid molecule of the string. In this way the metal is propelled one way, and the acid drawn in the opposite direction, and slow decomposition results at each node.

From the behaviour of electricity on all occasions, one would judge that it is not a substance of any sort, but a vibration—a vibration that finds itself in harmony with metal almost exclusively. As heat and light are to æther, and sound to grosser air, so is electricity to gross metal.

But this paper was written to express ideas regarding the shape of molecules, and electricity, if the above is true, must be devoid of form.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Traube's Iodide Three-Colour Process.

Dr. A. Traube has recently worked out a method of three-colour photography that seems to carry us one step nearer the automatic reproduction of colour. Briefly stated, his method is: (1) the making of three negatives behind the three colour screens, as usual; (2) printing three transparencies by development, as in lantern slide making; (3) converting the metallic silver images of the transparencies into silver iodide; (4) soaking each iodide transparency in a dye of appropriate colour, which will combine with the silver iodide; (5) fixing out the silver iodide, leaving the image in dye only; (6) stripping and superposing, etc., as usual. The essential difference between this method and others is that the depth of colour in the three transparencies is not regulated by the skill or caprice of the operator but by the silver iodide image, for the dyes selected are of such a sort that they combine with the iodide in definite quantity, irrespective of the strength of the dye solutions and the time of immersion, providing only that there is sufficient dye and that the time is long enough for a complete action.

It is obvious that such a method gets rid of one of the prime uncertainties of the usual methods, to the extent, that is, that it removes depth of tint of the three components from the consideration and judgment of the worker. It may be worth while to give a short summary of the chief of the uncertainties that still remain. The fact that the dyes must be such as will combine definitely with silver iodide somewhat limits the number of suitable dyes, and the colour-screens or filters used in making the negatives must be adjusted as nearly as possible to the dyes selected. Each of these six colours is, therefore, only the nearest practical match to the colours theoretically desired. Granting

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that the three negatives are made on the same kind of plate and developer together, their relative densities will depend on the relative exposures, and these remain at the discretion of the photographer. There is also the fact that, other things being equal, red light generally gives a steeper gradation than green, and green steeper than blue, which has the effect of permitting the correct adjustment of the colours for one depth of tint only. And with whatever care a developed transparency is made its gradation is almost sure to vary somewhat from the reverse gradation of the negative it is prepared from. With all these inherent uncertainties and circumstances remaining at the discretion of the worker, it may be that the loss of the possibility of the final adjustment of the depths of the colours will be a practical disadvantage. But whether or not this may prove to be the case, the method will lose none of its interest, for it demonstrates how one uncertainty may be got rid of, and it is only by the gradual elimination of the difficulties that we can hope to eventually find how to reproduce colour as automatically as form.

The Developable Image.

Many investigators have recently recorded the results of their experiments on the possibilities of destroying the developable image by various means, endeavouring in this way to get at a more exact idea of what it really is. Oxidisers, in the chemical sense, are generally employed, and the action of potassium bichromate (and chromic acid) has given rise to considerable controversy. Some say that it destroys the developable image altogether, a statement that may be met with the obvious retort that failure to develop does not prove the destruction of the image, but only proves that under the particular conditions of the particular experiments the developer produced no result. Others say that it will not destroy it, but that by soaking an exposed plate in a solution of potassium bichromate and then well washing, before applying the developer, development is somewhat retarded. Mr. Sterry, in the March number of the Journal of the Royal Photographic Society, maintains that his experiments show that "potassium bichromate, chromic acid, potassium permanganate, bromine, etc," cause "a changed condition in part of the light *reduction* product," and claims "some indications that the action of light produces three different results."

I think that the records of the results of almost all such experiments are far too much mixed up with purely theoretical ideas. For example, Mr. Sterry himself emphasises *reduction* in the above sentence as if the action of light produced a something by reduction, and a something that is not a reduction product. Might we not equally well suppose that the light action gave a single product of certain properties, and that the bichromate changed it as a whole into something else, with different properties? As I have said before, the nature of the developable image, if ever it is discovered, will not be proved by the action of any one reagent or of all possible reagents upon it, but by getting together *all* its known properties and then finding a something, a theoretical something, perhaps, that would at the same time have *all* these properties and lead to all known results. If all the purely experimental results as recorded were collated, it would be found that some would appear to be contradictory to others, while some would be supported by quite insufficient evidence to accept them as established. The experimental foundation that is the most reliable is that which has been confirmed over and over again by many individuals and under innumerable conditions, but this is too often put altogether on one side in favour of a single series of experiments.

Received.

"Real Orthochromatism" from Messrs. Wratten and Wainwright, of Croydon—a distinctly useful and practical pamphlet.

"The Birdland Booklet," from Messrs. Sanders and Crowhurst, of Shaftesbury Avenue, describes the character and use of the "Birdland" camera made to the specification of Mr. Oliver G. Pike. It gives many interesting and some curious illustrations of the kind of work that the camera is suitable for. While made specially for the photography of birds, the camera is equally convenient for the general use of a naturalist who is interested in living and moving things of any kind, including even the larger insects, such as dragon flies.

"The 1907 Victoria Photographic Handbook and Catalogue," from Messrs. James Woolley, Sons, and Co., of Victoria Bridge, Manchester. After a few pages of instruction for beginners follows an inclusive catalogue of apparatus and materials.

"Cooke Lenses with Cameras," from Messrs. Taylor, Taylor, and Hobson. A fully illustrated price list of a large number of cameras, chiefly hand cameras, by nine well-known makers, with Cooke lenses fitted to them.

Any of the above will be sent post free on application.

"The Photo-Miniature" for January deals with "focal-plane photography," and gives a great deal of information on this subject. Of course, "focal-plane photography" is nothing else than the use of a focal-plane shutter in giving the exposure, and such an instrument is occasionally useful and sometimes indispensable. There must, however, be something very wrong somewhere if even a focal-plane shutter in America will give a well-exposed negative in the seventy-fifth of a second with a lens aperture of $f/16$ after sunset, when a Wynne's exposure meter indicates that the exposure should have been nine hundred times as long. I prefer to believe that the error was not with the exposure meter.

Royal Meteorological Society.

AT the monthly meeting of the above Society, held on Wednesday evening, the 17th inst., a paper by Mr. R. L. Holmes on the "Phenomenal Rainfall in Suva, Fiji," was read by the Secretary, in the absence of the author. This was an account of a very remarkable fall of rain which occurred during a thunderstorm at Suva, the capital of Fiji, on the night of August 8, 1906. Unfortunately the exact amount had to be, in part, estimated, owing to the observer failing to measure the fall at intervals during the night. Very little rain fell before sunset, but from 6 p.m. it continued a ceaseless downpour till sunrise the next day. At 10 p.m. the assistant found the gauge overflowing with 12.50 ins. of rain in it. Four hours later, at 2 a.m., on the 9th, the gauge was again overflowing, and at 6 a.m. it was overflowing once more; that is three times in 12 hours. Very little rain fell after 6 a.m. These measurements show over 37 inches, without taking into account the overflowings, which is an unknown quantity. As the gauge was 25 feet above the ground, Mr. Holmes is of opinion the rainfall should be increased by about 11 per cent., so that the total fall must have been fully 41 inches in about 13 hours, which he thinks surpasses anything that has been recorded in any other part of the world in so short space of time. Mr. R. Strachan's paper on the "Temperature around the British Islands in relation to the Gulf Stream" was based on observations made during last year, and which have been published by the Meteorological Office. Around the British coasts the temperature of the air was lowest in February and highest in August; the temperature of the sea corresponded to these epochs with slight interruptions, having been lowest in January for the west and central, in March for the south, and highest in September for the north, and in July for the east positions. The water in the Strait of Florida was about 30° warmer than the sea at the north of Scotland. Mr. L. C. W. Bonacina also read a paper on "Weather regarded as a function of climate."

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Dew-Ponds.

By EDWARD A. MARTIN, F.G.S.

PART I.

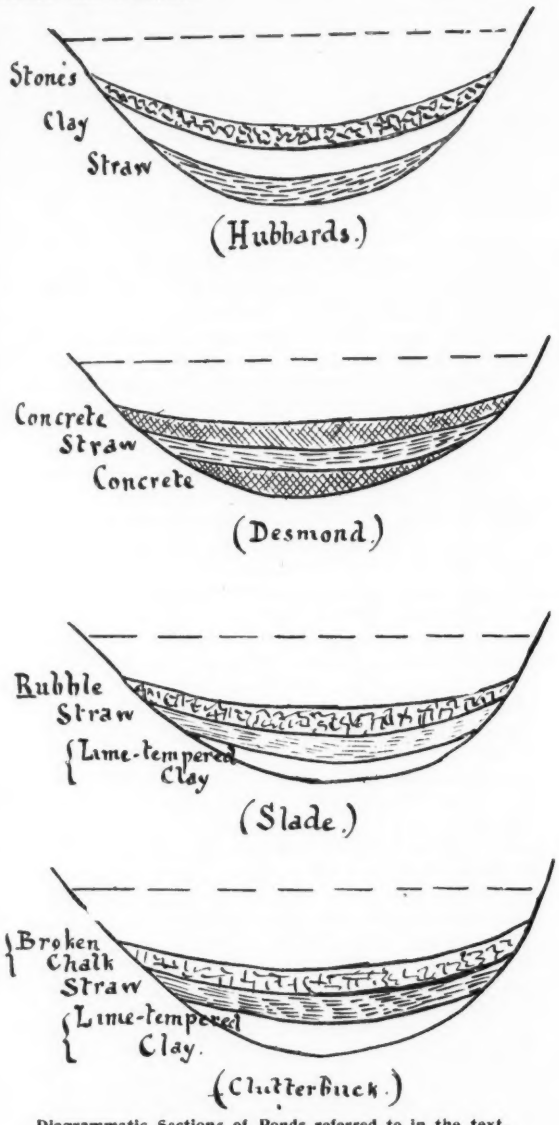
THE literature devoted to the subject of dew-ponds is of a very scanty nature, whilst those writers who have dealt with the subject differ considerably amongst themselves as to the principles, if any, on which such ponds are formed, and also, indeed, as to whether the ponds have any right to be called "dew-ponds" at all.

In considering the subject, it is, of course, primarily necessary to recognise clearly how dew is formed, but even in what appears to be such an elementary matter as this there is not a unanimity of opinion. Many meteorologists still maintain the old theory, which is certainly the popular theory, that dew is formed by the precipitation of the aqueous vapour already existing in the lower layers of the atmosphere, when the radiation of heat from the earth has caused its surface to be in the condition to chill below the dew-point the layer of saturated air in contact with it. Precipitated moisture may appear in the form of dew, hoar-frost, mist, fog, or cloud, but in dew and hoar-frost there is precipitation without a cloudy intermediary. Freest radiation of heat from the earth's surface takes place when there are no clouds to reflect to earth the heat which it gives off at night. If there are no clouds, the chilling of the ground and of the layer of air in contact with it will be considerable, and the temperature may be reduced to the dew-point.

During the last twenty years the acceptance of Dr. J. Aitken's theory has been rapidly growing, that dew is really formed from the moisture which rises out of the soil with the radiation of heat, and that it is this which is precipitated when the air into which it passes has been so reduced in temperature as to be unable to hold it as aqueous vapour. If this theory be the correct one it would at once dispose of the suggestion altogether that dew-ponds are fed and filled by true dew, since the acquisition of dew could only then be obtained at the expense of itself by earlier evaporation.

Messrs. Hubbard, in their "Neolithic Dew-Ponds and Cattleways," give some details as to the formation of these ponds, although the source of their information is not stated. They say that there is at least one wandering gang of men, who will construct for the modern farmer a dew-pond which will contain more water in the heat of summer than during the winter rains. The space hollowed out for the purpose is first thickly covered with a coating of dry straw. The straw is in turn covered by well-chosen, finely-puddled clay, and the upper surface of the clay is then closely strewn with stones. The margin of the straw has to be effectually protected by the clay, since if it becomes wet it will cease to attract the dew, as it ceases to act as a non-conductor of heat and "becomes of the same temperature as the surrounding earth." This would, of course, follow quickly if a runnel or spring were allowed to drain into the pond. The puddled clay is chilled by the process of evaporation, and the dry straw prevents the heat of the earth after a hot day from warming the clay.

It is very certain, however, that many alleged dew-ponds are not formed on this plan. This description, it will be observed, clearly presupposes that dew is formed out of aqueous vapour already existing in the atmosphere, so that if Dr. Aitken's theory is correct, it would seem that a new name is needed to describe water that is precipitated out of the atmosphere in such a case, without the intermediate condition of mist or cloud. Such might be called "invisible mist." Some remarks by G. G. Desmond in the Nature Notes Column of the "Daily News" gave a different arrangement for the basis of the dew-pond. It was there stated that first a bed of concrete is laid down; this is covered with straw, over which is placed another layer of concrete. I have been unable to trace the authority on which this is based.



Diagrammatic Sections of Ponds referred to in the text. Thicknesses greatly exaggerated.

In a private letter from the maker of some ponds on the "Duke of Norfolk Downs" and on Amberley Mount, it is stated that the highest parts are chosen, as they are "more exposed to the weather" than lower down, the inference being that they are filled by the moisture-laden winds blowing in from the south-west, no consideration being given whatever to any artificial attempt to attract dew-precipitation. But as R. H. Scott says, dew can never appear when there is much wind, for the air cannot remain long enough in contact

with the soil for any material reduction of its temperature, and consequent condensation of moisture to take place. ("Int. Sci. Series," Vol. XLVI.) The "weather" referred to can only, therefore, be mist or fog.

In 1877 Mr. H. P. Slade discarded the term "dew-ponds" in favour of "artificial rain-ponds," and scouted the idea that dew had any part in filling ponds at all. His remarks dealt practically with one pond, the greatest diameter of which was 69½ feet, which was constructed in 1836 at a cost of £40. It was bedded in the Thorpe Downs, near Loughborough, on the Berkshire Hills, at a height of 450 feet above the level of the sea. Being "fed from the heavens," this fact probably gave rise to its being classed as a dew-pond. The basis of this pond was stated to be, first a layer of clay about 12 inches thick (mixed with lime to prevent the working of earth-worms), second, a coating of straw, "to prevent the sun cracking the clay," and, thirdly, a layer of loose rubble. During an interval of 40 years, till 1876, the pond had only once been dry. The exception was in 1854, and this resulted principally from the growth of rushes, whose roots struck through the clay bottom, causing leakage in what was otherwise "a waterproof bed." The straw was not held to have any particular effect in causing dew-precipitation, and the rubble, which would, of course, by the way, allow of the straw becoming saturated, was merely to prevent the hoofs of cattle trampling upon and perforating the clay, or puddle, as it is called.

Gilbert White's mention of the little ponds on the downs around Selborne is an early reference to this class of pond, but he does not actually call them "dew-ponds," so that the name may have come into use subsequently to his time. He says: "Now we have many such little round ponds in this district; and one in particular on our sheep-down, 300 feet above my house, which, though never above three feet deep in the middle, and not more than 30 feet in diameter, and containing, perhaps, not more than two or three hundred hogsheads of water, yet never is known to fail, though it affords drink for 300 or 400 sheep, and for at least 20 head of large cattle beside. This pond, it is true, is overhung with two moderate beeches, that, doubtless, at times afford it much supply; but then we have others as small that, without the aid of trees, and in spite of evaporation from sun and wind, and perpetual consumption by cattle, yet constantly maintain a moderate share of water, without overflowing in the wettest seasons, as they would do if supplied by springs. By my journal of May, 1775, it appears that 'the small and even considerable ponds in the vales are now dried up, while the small ponds on the very tops of hills are but little effected.' Can this difference be accounted for from evaporation alone, which certainly is more prevalent in bottoms? or, rather, have not those elevated pools some unnoticed recruits, which in the night time counterbalance the waste of the day; without which the cattle alone must soon exhaust them?"

White then quotes Dr. Hales as remarking "that more than a double quantity of dew falls on a surface of water than there does on an equal surface of moist earth," but one must remark that this does not necessarily always hold good.

J. C. Clutterbuck, in 1865, said that in making such ponds an excavation was made in the chalk on the tops of the hills, from 30 to 40 feet or more in diameter, and from four to six feet deep. The bottom was "covered with clay carefully tempered, mixed with a considerable quantity of lime. . . ." This was "protected from the action of the sun and atmosphere by a covering of straw." After this "efficient and impermeable coating or puddle" is completed, "a layer of broken chalk is placed upon it."

It will have been noticed that in Messrs. Hubbard's statement, the excavated hollow is, in the *first* place, covered by straw, after which puddled clay is deposited thereon, with a strewing of staves on the top of that.

I should like to trace the wandering gang of men referred to in their work. I hoped to have hit upon some of them in the summer of 1906, when I found that a pond-maker, who seemed to be well-known, was said to be at Alfriston. I interviewed him on the subject, but only found that the ponds which he made, whether on high or low ground, consisted of an excavated hollow, with a carefully concreted bottom. With thermodynamics he had nothing to do, nor did he show any inclination to advance the cause of science by building a scientific dew-pond. For £30 or £40 he would build one anywhere, but he would choose a site where runnels made their appearance in rainy weather.

In Johnson and Wright's "Neolithic Man in North-East Surrey," reference is made to the fact that some old Surrey people do not use the term "dew-ponds" at all for these remarkably constant supplies of water which are found on the chalk hills, but call them "mist-ponds," and the more inquiry is made into the origin of them, the more difficult it is to think of the majority of them as *dew*-ponds in the full sense of the word.

(*To be continued.*)

CORRESPONDENCE.

Fresh Water Algæ and Animals.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—It is worth noting that there is a connection between freshwater algæ and animals. In this locality, for some years, I have worked pretty closely at the freshwater algæ in connection with the *Botanist's Guide for Renfrewshire*. A fair summary of my results is given in the *Handbook on the Natural History* in connection with the British Association when it met at Glasgow in 1901. Towards the end of 1901 I observed that if certain animals or insects were kept in water there often appeared in that water a fine crop of freshwater algæ. To make certain that the animals or insects had about them that which gave rise to the algæ, I had them put into sterilized bottles, flasks, or tubes, among boiled water. This, of course, made certain that neither the vessels nor the water could contain that which could give the start to algæ life. Into all the vessels and water so treated when insects or animals were introduced there was ultimately a yield of fine freshwater algæ. From 1902 on to 1906, in all four years, I have carried on these experiments with practically the same results. By this means I have been able to add many more species to those which appear in the British Association's list of the freshwater algæ of 1901.

Several of these algæ thus obtained have been shown to Professor G. F. Scott Elliot, formerly Professor of Botany, Glasgow, who has confirmed and named several of the species thus obtained. While this is so, I feel certain that from this method of cultivating freshwater algæ species that are new to science are to be obtained, and I have met with those that I could not name.

In field collecting of freshwater algæ I have noticed in the neighbourhood of Loch Tem, in Inverkip, and on Garvock Hill, Renfrewshire, that the alga *Eremosphaera viridis* appears in great abundance on the spawn of the Scottish Frog (*Rana Scotica*), which might point to the same fact, *i.e.*, the connection between algæ and animals There the spawn in the early spring months is often an object of great beauty by its marked peculiar green colour, due to the above alga.

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Frogs put into water, as above, always give certain species of freshwater algæ. That much overlooked Newt, the Palmated Newt (*Molge cristata*), gives a very ample crop, and often very rare species. To give some idea of how rich a crop comes from this species, I had one in a clear glass chemical flask, about four inches in diameter, which became so filled by a moving beautiful green microscopical alga that the Newt was entirely hidden—so dense was the mass that only the tip of the tail or its snout was to be seen when it came against the glass of the flask.

I have made use of various species of water coloptera in these experiments, which gave a start to freshwater algæ in mostly all cases. I regard species of the genus *Ilybus* as the least productive. The "Whirl-gigs" I have always found most productive, especially is that the case with species of *Gyrinus natator*. This is a common beetle, and the species of freshwater algæ produced from it vary in specimens taken from different localities.

It will be observed in these remarks that the species of animals or insects that have a connection with the freshwater algæ are either amphibian or aquatic.

It may be asked how long do the freshwater algæ take to develop from the time of putting the insect or animal into the sterilized water? This is influenced by the temperature, and also the amount of bright day or sun light. The higher the temperature and the more bright light, the sooner are the algæ developed.

For the guidance of any who may be inclined to try these experiments, the following is taken from my 1904 journal. On March 10 (which is late) the temperature of the ponds had not reached that degree when frogs appear in the water. On breaking the ice of the pond and dredging below it *Notonecta* were got in abundance, and one single species of Newt. This was the Smooth Newt (*Molge vulgaris, Lin.*). This was put into a sterilized clear glass flask with water, also sterilized. The flask and Newt were exposed to a full western light. This Newt was for a time vigorous, then became sluggish, and on March 19 cast its skin. The cast skin was very perfect. From the time the Newt was put into water till the first appearance of the algæ, there was a period of 51 days, which took up to April 30. Ten days later, or at the end of 61 days, the algæ were examined microscopically and drawings made. There is the following note :—"This evening examined the freshwater algæ from the sterilized water with the Newt. . . Saw several moving cells; also some plant structure has begun. Is like a *Bulbochæta*." The drawing shows that under the microscope moving parts were given off from the alga.

It may be of interest to mention that the Newt in this case was quite healthy after casting its skin, and was kept for some time, when it and its cast skin were mounted as museum specimens.

The above is a very protracted example, but the development by the higher temperature and the greater abundance of light by the middle or end of May often takes place in a short time—a few days at most.

I think that were experiments on the same lines as the above carried on with animals or insects from different parts of these islands, our knowledge of the British freshwater algæ would be greatly increased.

Yours faithfully,

Laboratory of Science, Paisley, N.B. J. M. B. TAYLOR.

The Telectroscope.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The recent progress made by Dr. Korn in the electrical transmission of photographic images directs attention to the possibility of actual vision at a distance by this means.

The problem of "seeing along a wire" has always been most fascinating, and many have been the attempts to put it into practice.

The difficulty is the fact that the "plane of vision"—a two-dimensioned subject—has to be continuously reproduced at a distance by means of variations of electric current in a line wire—practically a one-dimensioned method of transmission.

The only direction in which success appears to be possible is the continuous representation of successive images, a method depending upon retinal fatigue, which is successfully in use in the cinematograph.

The problem of the "Telectroscope" would, therefore, resolve itself into the satisfactory performance of the following operations :—

(1) The division of the "plane of vision" on the transmitter into a number of sensitive points, such points to be sufficiently close together as to present a continuous surface to the eye.

(2) The quantitative transmission of the relative amount of light falling upon each "point" at a speed greater than retinal fatigue, so that the whole surface may be successively so dealt with as many times a second as is necessary for any images projected upon it to appear continuous, *i.e.*, say 10 times per second.

(3) The electrical transmission along the line circuit of the rapid variations of current necessitated in operation (2).

(4) The synchronous reproduction, at the "Receiver" end of the line, of illuminated points on the plane of vision.

The sensitive element, Selenium, or, possibly, an alloy of same, appears to have the properties demanded by conditions 1 and 2, but the question is, What rate will it work up to? This can best be ascertained by experiment, but results with the "Photophone" of Graham Bell appear to point to a working capability of 4,000 variations per second.

Condition No. 3 has been solved in modern telephone practice; the special conditions present no difficulty beyond the provision and very careful adjustment of certain special apparatus.

Condition No. 4 likewise presents little difficulty, high-speed synchronous working being at present largely in use in modern telegraphy, and the rapid variation of illumination can be easily effected by some form of "vacuum tube."

The results of experiments in these directions would prove highly interesting, as showing the possibilities, even if the practicability of the system proved beyond same.

There is one slight detail that might be suggested, *i.e.*, the reduction of the "sensitive points" to one by use of a moving screen and parabolic mirror.

April 12, 1907. JOHN L. DUNK.

Formation of an Elbow by Use.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Dr. F. Oswald observes of the Hopping Goby, that "the fore-fin has developed a distinct elbow-joint." It would be difficult to suggest any other cause for this structure required for "hopping," than the Lamarckian one, or the actual *response to use*. A parallel instance has occurred in man. The late Sir W. Savory described to me the case of a man, who had been a guard on the Metropolitan Railway, and was brought to St. Bartholomew's Hospital with his elbow crushed. The joint was entirely excised, and the man returned to his duty. This involved his swinging himself outside the carriages to get to his own compartment after the train had started. The use of the arm for this purpose developed "a perfectly efficient elbow," as Sir W. Savory remarked; but of what structure it was made, whether of bone or cartilage, or both combined, was not known.

GEORGE HENSLOW.

Answers to Correspondents.

"E. F. T." writes to ask whether the goldfish purchasable for a few pence each in this country are imported from Japan, and if so, in what manner. Goldfish are natives of the warmer parts of China and Japan, but in a wild state are similar in colour to the Crucian carp, now common in England, the loss of the dark colouring matter being brought about by domestication. Most, if not all, of the specimens offered for sale are, we believe, bred in engine-tanks and suchlike places in this country. The so-called "telescope" and "double-finned" goldfish are, however, we believe, imported, and are much more valuable, selling from 7s. 6d. to 10s. each.

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NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S

Characteristic Phenomena of Sun-Spot Spectra.

MESSRS. HALE AND ADAMS have continued their work on sun-spot spectra, and have recently published a further list of comparisons with terrestrial lines, the discussion of these giving most important information respecting the relation of spot phenomena to the general solar surface. It will be remembered that in a former paper they showed that the lines strengthened in spot spectra are in general strengthened in the laboratory when the vapour producing them is reduced in temperature.

As instancing the relatively cool vapours of the spot, conclusive evidence is furnished of the presence of the flutings of titanium, and an excellent photograph showing this is included in the paper, with the flutings at λλ 7054.6, 7088.0, and 7125.9, most clearly indicated. Full detailed tables are given, showing the measured lines in the spot and flame spectra, and also of corresponding lines in the spectrum of the disc, where they occur. An analysis of this table gives as result that out of a total of 234 spot lines, 152, or 65 per cent., were coincident with titanium lines. The titanium flutings are not present in the spectrum of the disc itself, and it is therefore concluded that the temperature of the reversing layer is normally too high to admit of the presence of the band spectrum of titanium.

The importance of the investigation of the motion in the line of sight of the spot vapours, as bearing on the theory of spot structure, has been kept in mind during the work. Careful study of the plates has led to the conclusion that there is generally very little radial motion in spot umbræ. In the few cases where it has been detected, it was directed downward, and amounted to about 0.2 km. per second. It would appear then, that the vapours forming the umbra of a well-developed spot are normally almost at rest, with perhaps some indication of a slow, downward drift.

Dealing with the temperature of spot vapours, the presence of the flutings of titanium, which are absent from the solar spectrum, leaves little doubt that the vapours of sun-spots and third-type stars are cooler than the corresponding vapours in the reversing layer.—(*Astrophysical Journal*, 25, p. 75, March, 1907.)

Studies of the Infra-Red of the Solar Spectrum.

M. G. Millochau has for some time been investigating the infra-red region of the solar spectrum, in connection with the problem of detecting the solar corona without the intervention of a total eclipse. During some recent work at the Janssen Observatory, on Mont Blanc, his experiments have followed the line of the method described by Waterhouse, in 1875, based on the reversing action of the infra-red rays on sensitive plates; which consists in first fogging an ordinary plate and then exposing it to the action of the solar spectrum. It was noticed that under this treatment the action of the infra-red was superficial, and this led to the repetition of the work with plates strongly stained with special dyes, known to absorb the actinic rays. Good results were obtained at first with chrysoidine and erythrosine. Later, much better effects were obtained by the use of malachite green. Lumiere Σ plates were bathed for 10 minutes in distilled water, acidulated with a few drops of acetic acid, then for the same time in a saturated alcoholic solution of malachite green, rapidly rinsed and dried. All these operations take place in the dark.

The veiling of the plates was produced by a preliminary exposure of 30 seconds, at 75 cm. from an electric lamp of 4 candle-power. Stronger effects were obtained by exposures of 3 or 4 minutes through a blue screen, at 30 cm. from the lamp.

The plates were then exposed to the solar spectrum in the grating spectrograph (objectives 3 cm. diameter, 60 cm. focus), and the resulting negatives showed the infra-red spectrum from λ 7500 to λ 9500 distinctly. Photographs in the third order spectrum showed that the structure of the "A" group is similar to the well-known rhythmic grouping of "B." The ray *z*, pointed out in July as a short band fading towards the infra-red, is now resolved into lines in the spectrum of the second order.

Under favourable conditions an exposure of 10 minutes is sufficient for the region about "A," and 30 minutes for the part beyond, using the second order grating spectrum.—(*Comptes Rendus*, 144, p. 725, April 8, 1907.)

Standard Stellar Magnitudes.

Professor E. C. Pickering proposes a simple method of determining the photographic magnitudes of stars, on a uniform scale, which has been perfected during several years of its employment at the Harvard College Observatory. Its advantages are that no special apparatus is required, and the results obtained in practice are very satisfactory.

A standard sequence of comparison stars near the North Pole has been selected, and their photometric magnitudes determined from a large number of measures with the 4-inch and 12-inch meridian photometers. The positions and magnitudes of these stars are given, with instructions for their recognition on plates of the region previously published in Vol. 48 of the *Annals*.

To determine the photographic magnitudes of stars on this scale, a photograph is first taken of the North Pole, and the standard stars are marked on it. The plate need not be a good one, so long as it shows a certain pair of the stars, and it can be used indefinitely for stars in all parts of the sky. A second plate is then taken of the stars to be measured. The stars whose magnitudes are required, are marked on this plate, or, better, a sequence of stars is selected and marked, each star being slightly brighter than the one next it, and including stars brighter and fainter than any that are to be measured. The third plate is the important one. This must be taken when the sky is perfectly clear, and free from clouds or irregularly distributed haze, and at a time when the given region is at nearly the same altitude as the Pole. Under these conditions a photograph of the special region is taken in the usual way, and a second exposure of *exactly the same duration*, is made upon the Pole. It is essential that the images in the two exposures should be so nearly alike that they cannot be distinguished easily. The stars of the Polar sequence can now be transferred to this photograph by superposing it on the polar plate. The other stars are then similarly marked by means of the second plate. The relative brightness of the two sets of images is then measured by any convenient method, such as the determination of the diameter of the star images, or the method described at length in *Harvard Annals*, Vol. 26, p. 249. This gives the relative magnitudes on an arbitrary scale, which can at once be transformed into absolute scale by graphical plotting.

New Comet (1907 b).

The Kiel Centralstelle has circulated by telegram the discovery of a new comet by Mr. Mellish, of Madison, U.S.A., on April 14. The object was only faint, being estimated at the eleventh magnitude, and is notable for showing very considerable daily motion.

At discovery its position was—

R.A. = $6^h\ 40^m$) 1907, April 14th, $10^h\ 20^m$ (Madison
Decl. = $+8°\ 0'$) Mean Time.)

A later telegram announces that this comet has been observed by Bianchi, at Rome, on April 16, in the position

R.A. = $7^h\ 0^m\ 17^s{\cdot}5$) 1907, April 16th, $8^h\ 22{\cdot}1^m$ (Rome
Decl. = $+17°\ 19'\ 14''$) Mean Time.)

The object is thus travelling in a north-easterly direction from near ζ Geminorum.

XUM

BOTANICAL.

By G. Massee.

The Fungi of Certain Termite Nests.

It has been generally supposed that the first account of fungi being cultivated by ants for food was contained in Belt's "Naturalist in Nicaragua." Mr. T. Petch, who has given a very interesting account in *The Annals of the Royal Botanic Gardens, Peradeniya* of a similar habit practised by the termites in Ceylon, points out that Belt's account was antedated by nearly half a century by Smeathman, who observed the same phenomenon in Tropical Africa. In Ceylon, termite nests, or hills, are common except in the highest districts. The nests are roughly conical, the largest being about six feet high; the part of the nest below ground is usually much more extensive than that above. The chambers, which are numerous, are almost filled by a structure which resembles in form a coarse sponge-bath, and consists of a labyrinth of galleries opening into one another by perforations in all directions. This substance is known as "comb," and serves the termites as a fungus-garden, nursery, and living room. The substance of which the combs are formed consists exclusively of the excreta of the termites. The combs are present in every chamber except the royal cell, which contains the enormously distended queen and her smaller consort. The surface of the comb is covered with a layer of fungus mycelium, from which spring numerous very short tufts of mycelium, each of which bears a cluster of minute spherical or oval cells or conidia. These conidia are eaten by the termites. This formation of conidia is all that occurs on a normal comb. When the comb is old an agaric grows upon it, which is stated to be a modified *Volvaria*, whatever that may mean. The value of this fungus-garden to the termites is indicated by the fact that when pieces of a comb are broken they are carefully restored, even when the chamber contains neither eggs nor larvæ. When a comb is placed under a bell jar and allowed to remain away from the influence of the termites, other kinds of fungi appear, more especially a species of *Xylaria*, allied to the common British species known as "candle-snuff fungus." As these fungi do not appear when the comb is in the nest, and the growth utilised by the termites, it suggests a weeding out of those kinds of fungi that are not appreciated as food. A sterilisation of the material forming the comb, as it passes through the alimentary canal, is probable. As termites, at least in certain stages, are dependent on the fungus food growing on the comb, it was thought that the destruction of the fungus by the use of sulphate of copper in solution might involve the death of the insects. As a preliminary experiment, 18 gallons of water were poured quickly into a nest. This disappeared without filling the entrance. Another nest was selected and water poured down for two hours through a pipe delivering 15 gallons per minute. This was equally fruitless. On the nest being opened the earth round the lowest chambers was damp, but no water had entered any of them.

Many details respecting the everyday mode of life of termites or "white ants" are also given in this very interesting and important contribution to the knowledge of this fascinating group of insects.

Rate of Development in Certain Fungi.

Dr. Cobb, in dealing with fungus maladies of the sugar cane in Honolulu (*Bull. No. 5, Expt. Station Hawaiian Sugar Planters' Assoc.*), gives a very interesting account of the development and mode of spore dispersion of a fungus called *Ithyphallus coralloides*, a species closely resembling our common Stinkhorn (*Ithyphallus impudicus*). This fungus proves very destructive in the cane fields, its long, white, cord-like mycelium running underground and attacking the roots. The fungus varies from four to six inches in height, the stem is rose-colour, changing to orange when old, and the cap, which resembles a thimble placed on the top of the stem, is covered with a dingy olive glutinous mass containing myriads of very minute spores. The entire course of development is completed underground, during which period the spore-bearing portion is enclosed in an egg-shaped sheath or volva, which becomes ruptured to admit of the extension of the stem into the air at maturity, for the purpose of facilitating the distribution of the spores. A series of observations showed that when the spores are mature and ready to be conveyed above ground, the first decisive movements take place at about three in the morning, and consist in a gradual elevation of the egg-shaped volva, which, by daybreak, has just appeared above ground. During this process of elevation the top of the volva becomes transparent and thin, and is finally ruptured by the upward pressure of the cap bearing the spores. When the thimble-shaped cap is out of the volva and free from restraint the stem suddenly increases in length, and attains a height of several inches in less than a minute. After the first sudden rush the rate of elongation slows down, and usually comes to a standstill within an hour. The main portion of "growth" takes place, as a rule, inside of five minutes, and not infrequently it takes place in half that time, so that it is hardly out of place to say that the fructification "pops" out of the ground at sunrise in such a manner that the inner spore-bearing part becomes outside and apical. This sudden increase is not due to true growth; that is, to the division and production of new cells, but to the sudden expansion in size of cells already formed.

The spores are mainly distributed by flies, who feed on the evil-smelling glutinous substance containing the spores, being attracted to the fungus by its bright colour and strong smell. The spores retain their vitality for months after passing through the digestive tract of a fly. The spores are also carried on the feet of flies; from 7,000 to 8,000 spores are deposited for each foot-print after a fly has had its feet in the slime. This number gradually decreases as the fly travels along.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

Arsenical Springs.

In examining the sediment of the mineral spring known as the Maxquelle, at Dürkheim, for radio-active elements, Dr. Ebler made the remarkable discovery that the deposit contained 10.5 per cent. of arsenious oxide—a larger amount than has yet been recorded as occurring in the sediment of any spring. The water itself, which remained perfectly clear when protected from contact with air, also contained so much arsenic that it gave a precipitate of arsenic sulphide when treated, without being concentrated, with sulphuretted hydrogen. Quantitative determinations made during the summer and in December of last year showed that the amount of arsenic was as high as 17.4 milligrammes per litre. So large a proportion of arsenic in a mineral water is very rare, and is only known to be surpassed by the Roncegno spring in South Tyrol, which contains 42.6 milligrammes per litre. The celebrated arsenic spring of Levico Vetriolo, in the Tyrol, contains only 6 milligrammes, and the Guberquelle, in Bosnia, only 4.8 milligrammes per litre. According to Professor Salomon, the Dürkheim well is undoubtedly of recent origin. In the better known Roncegno spring the proportion of arsenic shows considerable variations. It has its origin, in part, in old disused shafts of mines containing arsenic ores, whence it is conducted to cisterns to be diluted to the strength required.

The Presence of Helium and Argon in Common Rocks.

The fact that radium has been found in granite and similar rocks suggested to the Hon. R. J. Strutt the possibility that helium might also be present in sufficient quantity to be identified. Experiment showed this to be the case, for on heating 250 grammes of Matopo granite 3 c.c. of impure nitrogen were obtained, and this, when sparked down, left a residue of about 0.03 c.c., which gave brilliant spectra of helium and argon of about equal intensity. Similar results were obtained with syenite rocks, and Mr. Strutt

suggests that his observations may explain the invariable presence of helium in the gases given off by hot mineral springs; for it is possible that these gases may have been set free from the rocks by the disintegrating action of the hot water. A further examination of the gases contained in ordinary (inactive) minerals showed that beryl yielded an amount of helium very different from that contained in such minerals in general. Thus, 250 grammes of New Hampshire beryl gave off 4.2 c.c. of helium, and this was the more remarkable in that the mineral was apparently absolutely devoid of radio-activity. In Mr. Strutt's opinion this is an instance of rayless change, and it is suggested that the element beryllium may be the constituent of the mineral which is concerned in this transformation.

A Property of Platinum Amalgam.

One of the last discoveries of the late Professor Moissan relates to a curious property of platinum amalgam. If mercury be shaken with water the two liquids speedily separate into distinct layers, but if the mercury contain platinum in solution the mass swells up to about five times its original volume, forming a lasting emulsion, which, under the microscope, can be seen to consist of minute globules of metal and water. So persistent is this emulsion that it can be kept for 12 months without showing any signs of diminishing. It can be heated to the temperature of boiling water or cooled to 80 degrees below zero without separating, and even when left in a vacuum only a little water is detached and a few bubbles of gas given off. Other liquids can take the place of water in this emulsification, analogous products being obtained with alcohol, ether, ammonia solution, turpentine oil, and chloroform, but, curiously enough, not with benzene. Amalgams of silver, gold, and copper do not behave in this way, but separate from the water as readily as mercury alone. The addition of sodium to the platinum amalgam does not interfere with the emulsification, a mass five or six times the volume of the original substance still being obtained.

Dangerous Dusts.

The risks of explosion in flour mills were discussed last year by Mr. Watson Smith ("KNOWLEDGE AND SCIENTIFIC NEWS," 1906, p. 388), and his communication has led Mr. S. F. Peckham to call attention to the occurrence of dangerous dusts in other factories. After the terrible explosion in 1878 in Minneapolis, in which three flour mills were destroyed, a simple apparatus was devised by Professor Peck for testing the explosibility of the dust, and it was demonstrated that the ignition of 2 ozs. of flour in a box containing two cubic feet of air would cause an explosion of sufficient force to raise two men standing on the lid of the box. Hence a sack of flour ignited in 4,000 cubic feet of air would be capable of throwing 2,500 tons to a height of 100 feet. The right proportion of air to dust is necessary for an explosion, just as in the case of mixtures of coal gas and air. With this apparatus Mr. Peckham has shown that the dry dust in wood-planing factories can be made to explode as readily as flour, and that, in fact, any dust that will burn may become a source of danger. For instance, an explosion in a confectionery works in New York was traced to the sugar powder; whilst dry soap dust was found to be responsible for a terrible fatality in a soap factory. Hence it is of the utmost importance that no dust should be allowed to accumulate in any factory where it is possible to prevent it doing so.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Stalactites of Tubular Calcite.

THE Bulletin of the Department of Geology of the University of California is issued at irregular intervals in the form of separate papers or memoirs, each of which embodies the results of research by some competent investigator in geological science. Some seventy-three such papers have been issued, and these contain a mass of information in reference to the geology of the State, and will be of immense value to future students and prospectors. The numbers are bound up as completed into volumes. From Vol. V., No. 6, we find that during the exploration of the Potter Creek cave in Shasta County, W. J. Sinclair collected some of the smaller stalactites which abound in the cave. These consist of tubular calcite, forming hollow cylinders, although the ordinary stalactitic shapes were common; their formation was due to continued crystallisations of rhombohedrons. The tubes are several inches long, their round surfaces show the outlines of small rhombohedrons, and they break always with the calcite cleavage. The stalactites also show the outlines of crystals, and their points are always terminated by a clear crystal. They are continually wet, water filling their hollow centres and constantly dripping from them, so that the growth is, says Mr. A. S. Eakle, by successive crystallisation instead of the common evaporation and deposition of the carbonate.

Geology of the Birmingham District.

I am glad to notice the re-publication of Lapworth's "Sketch of the Geology of the Birmingham District," reprinted from the Proceedings of the Geologists' Association for 1898. The book also contains contributions by W. W. Watts and W. Jerome Harrison, whose names are sufficient commendation of the volume. Not the least fascinating portion is that which deals with the Pre-Cambrian or Archæan rocks in or around the near neighbourhood of the city. These show themselves at Caldecote, along the north-eastern edge of the Cambrian area of Nuneaton, and at the inlier of Barnt Green, at the south-eastern extremity of the Lower Lickey Hills. Three other areas of these fundamental rocks occur along the outer margin of the Birmingham District, namely, at the Malvern Hills, the Wrekin Hills, and at Charnwood Forest. The exposures occur only

along the axes of some of the chief anticlinal forms, and are for the most part of insignificant extent, although they may be regarded as the "basement" of the district, underlying all the fossil-bearing geological formations. In the pre-Cambrian rocks of Charnwood Forest, where they occupy a considerable area, we have the most easterly exposure at present known in Britain. Only the higher peaks here are exposed above the general mantle of Triassic rocks, and they are mainly of volcanic origin. They include coarse breccias and agglomerates, conglomerates, tuffs, and fine-grained ashes, passing into hornstones and slates. Prof. Watts divides the Caldecote rocks into three broad series, known respectively as the Brand, the Maplewell, and the Blackbrook series. By the kindness of Mr. W. Jerome Harrison, F.G.S., we are able to reproduce one of his photographs of Pre-Cambrian rocks at Hartshill.

The Rocks Beneath the Weald.

The sub-Wealden Boring at Netherfield, in Sussex, was a matter of considerable scientific excitement to an older generation of geologists, and the results attained have again been brought to mind by a reference in a recent volume of the Proceedings of the Geologists' Association. The Purbeck Beds are found at the surface, and one result of the exploration was the discovery in them of several beds

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of gypsum at a depth of over 120 feet. At 170 feet the Portland Beds were reached, and these were found to be from 105 to 110 feet thick. Below these beds the Kimmeridge clay was discovered, and was found to have the extraordinary thickness of about 1,300 feet, after which came the Corallian series, with a thickness of about 240 feet. The boring ended in the Oxford clay at a depth of 1,900 feet.

Coal Measures under Surrey.

It is stated that a further attempt is to be made to obtain coal near the North Downs at Red Hill or Reigate. There is every reason why coal should be found somewhere on the line between Dover and Gloucestershire, if only the trial borings are made to a great enough depth. Many an announcement of the discovery of coal in the Wealden counties near the surface has been made, simply from the rediscovery by inexperienced persons of outcropping beds of lignite, or wood-coal. Attempts have been made to use the lignite commercially, and on one occasion a company was formed to exploit it, with disastrous consequences. It is to he hoped that the present venture has other fuel in view than lignite.

Owing to a number of Silurian fossils having been thrown out by moles and rabbits in the Eastern Mendips, the digging of a series of seven trenches was carried out, and the results have been published by Professor Sidney Hugh Reynolds, M.A., F.G.S., in a paper entitled "A Silurian Inlier in the Eastern Mendips." This proved that the fragmental igneous rock is of two types:—(1) Normal fine-grained tuff, from which in three localities over 30 species of Silurian (probably Llandovery) fossils were obtained and have been identified by Mr. F. R. Cowper Reed; the tuffs are seen at Sunnyhill to underlie the trap. (2) A remarkable coarse ashy conglomerate, the nature and relation of which to the other rocks are both obscure. Professor Reynolds is of opinion that it represents the necks of the volcanoes from which trap and normal tuff were ejected. In discussing the paper before the Geological Society, Professor Sollas remarked that he felt grateful to the author for removing a grievance which he, in common with all students of the locality, felt that they had against the Mendips, since these mountains seemed to promise, fold after fold, to bring Silurian to the surface, without actually doing so. Now they learnt that, in its very last fold before this range plunged out of sight beneath the sediments to the east, the promised Silurian had appeared. If the determinations of the palæontologists as to the horizon of the Silurian could be accepted, general conclusions of an interesting nature followed, for both Gower and the Mendips lay on the northern boundary of the Armorican chain, and the absence in these regions of the higher members of the Silurian suggested that a folding, which as the antithesis of posthumous, might be spoken of as prophetic, had already marked this line of weakness.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c

The Display of the Kagu.

THOSE who may have the good fortune to be able to visit the Gardens of the Zoological Society just now may, perchance, be lucky enough to witness the display of that rare bird, the kagu (*Rhinochætus jubatus*), of New Caledonia. This bird, a male, in moments of excitement, assumes the curious postures which, in its wild state, are reserved for the edification of its mate.

When worked up to the correct pitch, so to speak, the neck and body are raised to an almost vertical position, the wings are half-opened, and thrust forward, and the head is bent so that the beak rests upon, or, rather, is half buried among, the neck feathers. Then the long, pendant crest is set on end so as to form a wide, upstanding fan, of great beauty. The effect of this display is further heightened by the fact that the bird, as if conscious of its charms, struts up and down with a curious mincing step, assumed only at this particular time. But the performance is of short duration, a few seconds only, though repeated encores may sometimes be secured.

Waxwing in Surrey.

Mr. Grayhurst Hewat writes to the *Field* (March 23) to say that he had the good fortune to see a waxwing near Long Ditton on March 17. It was very tame, and allowed him to get within a few feet, so that the "wax" tips to the secondaries could be plainly seen.

Hoopoe in Gloucestershire.

In the *Field* (April 13) the fact is recorded that a hoopoe was seen at Henbury on March 31. We trust that every protection will be afforded this bird, if only in the hope that its mate may be in the neighbourhood. Hoopoes have bred in this country before, and would do so again but for the "collector."

Arrival of Summer Birds.

The following have been reported:—

Chiff-Chaff—Horsham, March 23.
Wheatear—Salisbury Plain, March 22.
Willow Wren—Birmingham, March 30.
Blackcap— Hitchin, March 24.
Wryneck—Hitchin, March 26.
Swallow—Goresbridge, Co. Kilkenny, March 29.
Sand Martin—Romsey, Hants., March 27; Seaton, Devon, March 23; Lynn Coran, Anglesea, March 27.
Ring Ousel—Windermere, April 3.
Redstart—Seaford, Sussex, April 6.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

The Density of the Æther.

IN the "Philosophical Magazine" for April, Sir Oliver Lodge discourses on the probable density of the æther. The estimate is based on the assumption that matter itself may consist of bodies having the character of minute charges—configurations of æther of some kind—moving about freely and endowed with a definite mass and bulk. If this assumption is true, it is apparent how very porous a structure matter must exhibit to everything except electrical disturbance, for the interstices must be enormous compared with the regions of definite structure. Combining this view with the great probability that the æther is practically incompressible—as indicated by the results of the Cavendish experiment (repeated with refinements by Maxwell) on the absence of force inside a closed conductor due to charges outside it—it is inferred that the mass of that part of the æther forming the atoms in unit volume of any substance is very small compared with the total mass of æther in the unit volume. Thus, taking platinum, and assuming that its atoms are composed of electrons, the space which these electrons actually fill bears to the whole space which they "occupy" a ratio comparable with the number 10^{-10}, so that a kind of minimum estimate of ætherial density, on this basis, would be something like ten thousand million times that of platinum.

In order to make such an inference it is necessary to understand exactly what is meant by the mass of an atom. The simplest mode of regarding the question is to suppose that an electron is a volume of "coagulated" æther moving through the surrounding æther. Now, hydrodynamically, it is known that if a sphere travels through a fluid without setting up any rotational motion in it, the disturbance produced in this fluid adds to the real mass of the sphere an amount equal to the mass of half the volume of fluid displaced. Thus, if this simple view of the question were the correct one the estimate of the density of the æther would be still comparable with that made above. It is known, however, that the apparent mass of a moving charge can be more definitely expressed in terms of the surrounding magnetic field set up round it due to the motion, and Sir Oliver Lodge shows that this more elaborate and truer

consideration of the behaviour of an atom leads to the same order of estimate of the mass when expressed in terms of the volume of æther contained in it.

An interesting deduction is made of the energy of the æther, viz., 100 ft. lbs. per atomic volume. This is equivalent to saying that 3×10^{17} kilowatt hours, or the total output of a million kilowatt power station for thirty million years, exists permanently, and at present inaccessibly, in every cubic millimetre of space!

The reason that the great density of the æther is not felt mechanically is that the æther cannot be moved by mechanical means.

The Spectra of Hydrogen.

In the "Journal de Physique" M. A. Dufour details experiments made on the spectra of hydrogen with the object of elucidating the creation of the second spectrum. In examining the Zeeman effect for the lines in this second spectrum he finds that some lines are not altered in a magnetic field; these are the most numerous. Others behave analogously to sodium lines; others, again, exhibit the phenomenon of "inversion," pointed out first by Becquerel and Deslandres for certain rays of iron; the separation between the components is greater for vibrations parallel to the magnetic field than for others. This last effect, which is very rare, occurs without any doubt for the ray of wavelength 600.225 $\mu\mu$. These results indicate that we should regard the second spectrum as formed of a collection of line and band spectra. In examining the question theoretically he considers that a satisfactory explanation of the two spectra can be obtained from the ionic theory in conjunction with the theory of the dissociation of hydrogen at small pressures and high temperatures. He considers that in the stars and the sun, whose light yields only the first spectrum, hydrogen is entirely dissociated into its atoms.

High-Tension Condensers.

Messrs. Isenthal and Co., of Mortimer Street, W., are showing some new technical high-tension condensers on the Moscicki principle, for which they have the exclusive agency. The essential peculiarity of these is that they are made dielectrically stronger where the usual condenser breaks down, viz., near the edges of the armatures. Each condenser consists of a cylindrical glass tube, the neck of which is three or four times as thick as the rest of the tube. The latter is covered inside and outside with a thin chemically deposited layer of silver, which, in its turn, is strengthened with a much thicker layer of copper. These deposits extend part way up the neck, the thickness of which obviates the breakdown which would occur if the glass were kept thin throughout. The glass tube is placed in an iron or brass tube, the intervening space being filled with a non-freezing mixture of distilled water and glycerine. The presence of this liquid increases the thermal capacity and prevents any great local rise of temperature which would tend to break the glass. The design of these condensers appears to be very good.

ZOOLOGICAL.

By R. LYDEKKER.

Extinct Malagasy Lemurs.

THE British Museum has recently acquired a most interesting series of remains of extinct lemurs and lemur-like creatures collected by Mr. H. F. Standing, in the intervals of his missionary work, from a swamp near Antananarivo, Madagascar. Some of the skulls are referred to species of the living genus *Lemur*, while others apparently indicate a transition from the existing short-tailed indri in the direction of an extinct type previously described as *Archæolemur*. Most interesting of all is, however, a new species of the extinct genus *Megaladapis*, considerably larger than any yet known, which must have been of the approximate size of an average leopard. Certain features in their structure suggest that some of these giant extinct lemurs may have been aquatic in their habits. There are also indications of affinity between some of these lemur-like creatures and monkeys, which has led their describer to conclude that we are not justified in referring lemurs and monkeys to distinct subordinal groups. Such a radical change requires, however, further consideration before it can be definitely adopted.

Black-and-Tan Dogs.

In last month's notes reference was made to recent investigations by Mr. Pocock with regard to the colour-pattern of domesticated cats. Mention may here be made to his recent observations on the nature of the black-and-tan type of colouring met with in various breeds of dogs, such as terriers, King Charles spaniels, and setters. In all cases where this type of colouring obtains it will be noticed that the black is restricted to the upper-parts and outer sides of the limbs, while the tan occupies the under-parts, the inner sides of the limbs, and certain patches and spots on the face. The tan thus corresponds to the light areas, and the black to the dark ones in wolves and jackals. The explanation is, therefore, obvious, namely, that black-and-tan is the halfway stage to complete blackness or melanism. Now that Mr. Pocock has made this clear, we shall probably be asking why we did not long ago find out such a simple matter for ourselves.

Ceylon Book-Lice.

Those interested in the smaller forms of insect life will appreciate Dr. G. Enderlein's discovery and description of a whole host of new Cingalese representatives of the group to which the European death-watch and book-lice belong. The insects described by Dr. Enderlein (in *Spolia Zeylanica*) are, however, furnished with scale-clad wings, the beauty of whose pattern and colouring is only rivalled by those of the Microlepidoptera. Hitherto comparatively few of these scaly-winged book-lice have been known to science, and the determination of a number not only of new species, but likewise of new genera, comes, therefore, almost as a revelation. Gold and silver and browns and greys are the predominating factors in the colouring of the wings of these minute insects.

The Whales of the Antarctic.

To pass from minute to gigantic animals, the next most important event of the month is the account given by the naturalist of the "Discovery" Expedition of two hitherto unknown cetaceans inhabiting the south polar ocean. One of these creatures is a black whale some five-and-twenty feet in length (so far as could be judged) characterised by having a tall, upright back-fin like that of a killer. The other is a brown and white dolphin, showing a type of coloration that leaves no doubt as to its specific distinctness. Coloured sketches of these interesting creatures, as observed from the deck of the "Discovery," are given in a volume on the zoological results of the recent Antarctic Expedition issued by the British Museum.

Papers Read.

At the meeting of the Zoological Society held on March 5, Mr. Rothschild described the Natal steinbok as a distinct form, and likewise described a lechwi antelope as intermediate in colouring between Livingstone's *Cobus lichi* and *Cobus smithemanni*. This suggests that all three are merely phases of a single species. The same gentleman also named an almost wholly black wild sheep from North America. Fossil dwarf elephants from cavern deposits in Crete formed the subject of a communication by Miss Bate. The other communications related to invertebrates; Messrs. Rousselet and Cunnington respectively discussed the polyzoans and the crabs of Lake Tanganyika, while Mr. Beddard described certain new worms. The crabs were not considered to lend any support to the now well-nigh discredited theory that Tanganyika contains a specially modified marine fauna.

At the meeting of the same Society on March 19 the *pièce de résistance* was a paper by Mr. H. F. Standing, on fossil lemurs from Madagascar, to which a separate paragraph is devoted above; while Dr. Sambon discoursed on certain new or little known parasites, and Messrs. Thomas and Wroughton contributed notes on a collection of African mammals.

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REVIEWS OF BOOKS.

AERONAUTICS.

Pocket Book of Aëronautics, by Major Moedebeck; English Edition, translated by W. Mansergh Varley (Whittaker and Co.; 10s. 6d. net).—This English edition, brought up to date, of one of the most complete works dealing with the subject of balloons, kites, and all matters connected with aërial navigation, will be highly welcome to all aëronauts. It may be said to be the only complete work dealing practically with such matters. Though modestly entitled "Pocket Book," it really forms a very exhaustive and compact treatise, running into nearly 500 pages. A list of the chapters, all of which are compiled by different well-known German authorities, will give the best idea of its comprehensiveness. The chapters are: "On the Physical Properties and the Technology of Gases"; "The Physics of the Atmosphere"; "Meteorological Observations in Balloons"; "Technique of Ballooning"; "Kites and Parachutes"; "On Ballooning"; "Balloon Photography"; "Photographic Surveying from Balloons"; "On Military Ballooning"; "Animal Flight"; "Artificial Flight"; "On Airships"; "On Flying Machines"; "On Motors"; "On Air-Screws"; "Aëronautical Societies"; Appendices, Tables, and Formula. All these many subjects are very fully dealt with, and numerous illustrations and diagrams accompany the text. The arrangement is, perhaps, not quite all that could be desired; for instance, the chapters on "Artificial Flight" and on "Flying Machines" seem to cover somewhat the same ground, as do those on the "Technique of Ballooning," and "On Ballooning." But it is difficult to avoid such interferences where many authors are writing on kindred subjects. There are also a few important omissions; for instance, we fail to find any reference to Dr. Langley's important experiments on aërodynamics. It seems unnecessary, too, in such a work to include drawings of crude ideas never carried out, such as those of Leppig's aërial ship, 1812; Bell's airship, 1848; and many others. But, notwithstanding these few small shortcomings, we have no hesitation in thoroughly recommending this as forming an absolutely indispensable book for all who are working at or interested in the subject of aëronautics.

B. B-P.

ANTHROPOLOGY.

"The Todas," by W. H. R. Rivers (London: Macmillan and Co., Ltd., 1906; pp. xviii. and 755, illustrated; price 21s., net).—Buried away on the undulating plateaus which form the heart of the "Blue Mountains" (Nilgiris) of Southern India, dwell a pastoral people, remarkable alike for their handsome, personal bearing and physiognomy, their elaborately ornamented and curiously constructed huts, and the sacred or semi-sacred cult of the dairies of buffaloe's milk on which they chiefly depend for subsistence. So absolutely shut out, indeed, were they from contact with the surrounding civilisation, that it was not until the year 1812 that the very existence of the Todas, as they are called, was made known to Europeans. Since that date these people, who differ so remarkably from all the surrounding tribes, have attracted a large share of attention on the part of anthropologists, and now form the subject of a considerable amount of literature. In spite of this, the author of the volume before us considered that there was still much remaining to be learnt about their social organisation, more especially as regards their system of kinship, and the practices of exogamy and polyandry. In this he was fully justified, and in place of finding (as he was told would prove the case) that nothing more remained to be learnt about this unique and picturesque people, it turned out that in the time at his disposal he was unable to push his investigations so far as he desired. Consequently, he claims the indulgence of his readers for the incompleteness of his book, which, it should be observed, is mainly restricted to the religious and sociological aspect of the subject. Most readers will, however, we venture to think, be impressed with the thoroughness with which Mr. Rivers has done his work, and the admirable model he has given of the form which modern anthropological researches should take. Moreover, despite the technical nature of a large portion of his subject, the author has succeeded in making a very readable book, illustrated with some striking portraits of male and female Todas, together with photographs of their unique dwellings. In short, it may be said that the volume before us is in every way an excellent piece of work, and a most valuable contribution to our knowledge of the anthropology of British India. It should be in the library of every member of the Indian Civil Service.

BOTANY.

Handbook of Plant Collecting, by J. M. B. Taylor (Paisley: Houlston and Sons; 6d. net).—As a rule much time is wasted on the part of incipient botanists in attempting to form a collection of dried plants without any previous knowledge on the subject. The little book under consideration is the outcome of much experience in this direction, and can be depended upon as furnishing the necessary information relating to the collecting, drying, preservation, and storing of plants. The preparation of skeleton leaves is also explained.

The Principles of Horticulture, by Wilfred Mark Webb (London: Blackie and Son, Ltd.; 2s.).—Mr. Webb has produced an excellent little book, embodying all the important underlying principles of horticulture. Numerous simple physiological experiments are given which, if carefully carried out, will enable the student to understand many facts bearing on the well-being of plant life. The same may be said of the lessons dealing with the structure of plants. There is an excellent account of the principles of Mendel's Law. Diseases caused by insects and fungi also find a place. The illustrations are numerous and to the point, the "annotated diagrams" being exceptionally clear and convincing.

Books and Portraits Illustrating the History of Plant Classification (London: British Museum—Natural History—Special Guides, No. 2, 4d.).—The production of this guide is a step in the right direction, and we trust is only the forerunner of many guides, tracing the growth of different sections of Natural History. Commencing with Dioscorides —A.D. 40—a brief sketch is given of the gradual evolution of the science of botany, from the time when the medicinal use and virtues of plants was the inspiring cause, up to the time of Adolf Engler—1903—whose works may be taken to represent the most modern and advanced phase of systematic botany. Portraits are given of John Ray, Carolus Linnæus, and Robert Brown. The guide has been drawn up to accompany a collection of books and portraits which has been placed in the first recess on the left-hand side on entering the Botanical Gallery.

HEREDITY.

Recent Progress in the Study of Variation, Heredity, and Evolution, by Robert Heath Lock, M.A. (John Murray; pp. 299; 7s. 6d.).—In his preface, Mr. Lock says that the idea of writing a brief account of the science to which Mr. W. Bateson has recently proposed the term "genetics" occurred to him while reading Mr. W. C. D. Whetham's volume on the "Recent Development of Physical Science." This remark conveys very fitly the aim and scope of the volume, if we add the proviso that, perhaps even more than Mr. Whetham's essays, it is directed to an audience which is trained in scientific methods rather than to the intelligent general reader. One of the chief difficulties which scientific men experience is that of keeping abreast and in touch with branches of science other than those in which they specialise. They have no time to digest the accumulating mass of original papers on these outside subjects; and in England, at any rate, the "popular book" on a branch of science, unless, perhaps, we except some of the applied sciences, is exasperatingly inadequate, and frequently obsolete or inaccurate. Mr. Lock is extremely well qualified to summarise and analyse the various views of heredity that have followed the establishment of the evolution theory, for he is one of the little band at Cambridge which, inspired by Mr. Bateson, has worked with such devotion and persistence at the modifications of the theory of evolution which are suggested by Mendel's experiments. From these experiments, and from the laws therefrom deduced or re-discovered, a new school of thought has arisen; and from its hypotheses, however much the future may modify them, or may endeavour to bring them in accord with the more

rigid theories of neo-Darwinism, a clearer vision of the truth must spring. Mr. Lock writes with a tolerance not often to be met with in the enthusiast. Specially to be commended are the chapter on Cytology and the account of Yule's attempt to reconcile the results obtained by the Biometricians with Mendelism. The subject of heredity, however, is not only of scientific interest, but is also of commercial and social importance. Mr. Lock has taken pains to fit his book for the general reader by carefully explaining some scientific terms and by giving a glossary of those not explained in the text. An intelligent inquirer can get a more useful idea of a science from the words of one who is himself engaged in research than from that class of book that may be more properly called "popular," written probably by an amateur, who slurs over difficulties and sacrifices accuracy to simplicity. Mr. Lock is admirably clear, and the more difficult portions, such as Cytology and the more advanced conclusions of the Biometricians, may be left unread with but little damage to the general effect. There are several examples given of the importance of recent work to agriculturists and breeders, notably Biffen's researches on wheat, and Mr. Lock's hopes of a possible fresh era of prosperity for the farmer seem justified.

E. S. G.

MICROSCOPY.

Animal Micrology: Practical Exercises in Microscopical Methods, by Michael F. Guyer, Ph.D.; demy 8vo., pp. ix. and 240; 71 illustrations (Chicago: The University of Chicago Press; London: T. Fisher Unwin; price 9s. net).—The general plan of this book is less that of a collection of microscopical technical methods than of a series of carefully selected practical exercises in general laboratory methods, based upon the experience of the author as a teacher. In these exercises the student is instructed in the various methods of preparing objects for section-cutting, in paraffin and celloidin embedding, in freezing, and in staining and mounting. The instructions given are eminently clear and practical, and an admirable summary is given at each step of the various difficulties and failures likely to be met with, and of the best way to rectify and deal with them. The staining methods selected are those most used in laboratories, and which are of broad, general application. These are dealt with in the earlier part of the book. Then follow methods of preparation of blood films, bacteriological methods, an excellent chapter on the preparation of embryological sections of the chick, rabbit, &c., and of a few selected objects of more general interest. There are five appendices which make up nearly half the book. The first deals with the microscope and its optical principles, and is a clear summary of considerably more value than is usually found in books of this description, though the author shows a want of familiarity with the use of the condenser, and a failure to appreciate the advantages of a critical image, with complete absence of the necessary instruction in obtaining such an image. There is also the usual confusion as to the respective magnifications of objectives and eye-pieces at varying tube-lengths. The second appendix contains formulæ for preparing various reagents; a third appendix contains a most useful table of tissues and organs with recommended methods of preparation (quite one of the best things in the book); the fourth appendix contains fuller particulars of the preparation of selected microscopical material for a general elementary course in zoology, and there is finally a table of weights and measures. Last, but not least, there is an excellent index. The book makes no pretensions to be a complete vade-mecum of microscopical methods, and many of the methods detailed could be improved upon, such as those for grinding thin sections of bone, and for mounting rotifera, whilst there are rather too many references to the now defunct "Journal of Applied Microscopy," which many readers may not possess. Such criticisms do not, however, affect the general excellence of the book, which can be heartily recommended to all solitary workers and to students generally, whilst even the practised worker may find assistance in the appendices.

F. S. S.

ORNITHOLOGY.

The Birds of the British Islands, by Charles Stonham (London: Grant Richards, 1907).—"The object," we are told, "in the production of 'Birds of the British Islands' has been to supply a work which shall be far in advance of anything of the kind which has so far been attempted." With so many good works published at a reasonable price, this was an ambitious object indeed, but the result, it must be confessed, is emphatically failure. So far but four expensive parts have been published, and these are certainly not only not in advance of such books as, say, Yarrell's "British Birds," Howard Saunders' "Manual of British Birds," or Sharpe's "British Birds," but they suffer severely in comparison therewith. It has been claimed for this production that in the matter of illustrations it is superior to any other book of its kind which contains uncoloured figures. This claim we certainly cannot admit. The figures which appeared in Part I. were decidedly not such as could command even mild praise, but those which have appeared in the succeeding parts show a most marked improvement. Some, indeed, are really very pleasing. But it cannot be claimed that any of these are superior to the best figures which appear in such works as Saunders' Manual, for example, which can be purchased for a few shillings.

W. P. PYCRAFT.

PHOTOGRAPHY.

Colour-Correct Photography, by T. Thorne Baker, F.C.S., F.R.P.S. (London; Dawbarn and Ward, Ltd., price 1s. net).—The author states that he writes for those who have "neither great theoretic knowledge nor great practical skill"; the volume is therefore essentially elementary and empirical. A little more explanation and even a little theory judiciously introduced would have made some points more clear, for the most empirical worker must be guided in some measure by general principles. Such a course would probably have led to the avoidance of the error of ascribing to the constant absorption due to the glass the fact that the increase of exposure is not proportional to the increase of colour in a colour filter, and to the modification of one or two other statements that do not appear to be justifiable. Those who have done nothing or little with colour-sensitised plates and colour-screens, will find this a useful volume, and those who have had more experience will find many a practical suggestion therein.

PHYSICS.

Radio-Active Transformations, by Prof. E. Rutherford, D.Sc. (Archibald Constable and Co.; 1906).—The present volume consists of a series of lectures given at Yale College, in connection with the Silliman foundation. The general phenomena of radio-activity are described with less detail than in Rutherford's previous book; the special stress being laid on the numerous transformations which matter is now known to undergo. When it is recalled that our present views on the subject are mainly those originated by Prof. Rutherford, every new statement made by him is of especial interest. An idea of present views may be obtained from the statement that radium may probably be regarded as a compound of lead and helium, whose formula is Pb. He_6 while in the same way uranium is Pb. He_8. It must be clearly borne in mind that these compounds are not ordinary compounds. Radium and uranium cannot be broken up by any chemical or physical processes at our command. The changes take place spontaneously, and the disintegration is accompanied by the expulsion of a helium atom with great velocity. The many problems, electrical and otherwise, connected with this expulsion are dealt with in detail. A very full study is made of the Alpha particles, and many results obtained during the past year have been incorporated in this valuable volume.

The New Physics and Chemistry. W. A. Shenstone, F.R.S. (Smith, Elder and Co.).—Anyone who is looking for a non-technical account of progress in various branches in science will find here just the book he wants. It consists of a reprint of essays, published originally in the *Cornhill Magazine.* If we refer to these essays as popularly written it must be understood that we employ the phrase in its best sense. They are successful attempts at a broad, rather than a minute, treatment of the different subjects dealt with; and being accurate accounts withal, it will be seen that they possess just those qualities which good, popular writing should have. The titles include the following, amongst others:—Matter, Motion and Molecules; On Weighing Atoms; Radium; Ferments and Fermentations; The Origin of Life.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

MICROSCOPY divides itself, naturally, into three divisions. Firstly, the microscope itself; its choice and how best to use it, and its accessories and how best to use them. Secondly, the preparation of objects for the microscope. Thirdly, the study of subjects which require the use of the microscope for their elucidation. There are many books which deal with the first division in a more or less practical way; not a few of these books contain information, elementary or otherwise, on the second division also, whilst other books confine themselves exclusively to more technical methods; and there are yet others which embrace all three divisions, endeavouring to cover the whole ground of animate, and even inanimate, nature in its microscopical forms or structure, and leaving special branches to be studied in more advanced works by specialists on individual subjects. In these columns I have endeavoured to keep my readers informed month by month, by reports of the meetings of various societies, and by special notes, of new microscopes, apparatus, and technique coming under the first head, of methods of preparation coming under the second head, and even in that much wider field, so embarrassing in its extent and in difficulty of selection, which is embraced by the third division. For the inadequacy of the last the vastness of the subject, the catholicity of the tastes and interests of the readers of this journal, and the manifest limitations of the space at my disposal must surely be sufficient excuse, and feeling the hopelessness of dealing satisfactorily with it, I have in these columns paid particular attention to the microscope, to microscopical methods and technique, and to special methods of mounting for the microscope, with such biological and other notes as I had space for, leaving special articles to be sought for in the other columns of this journal and elsewhere.

A good many years ago I wrote for another journal a series of articles on the microscope and how to use it, and these articles aroused so much interest that they were subsequently greatly enlarged and re-published in book form under the title of "Elementary Microscopy." With a view to rendering my readers in this journal as much practical assistance as possible, I have from time to time added notes on similar matters, which I thought might supplement existing text-books. Some months ago I also contributed to this journal a series of articles dealing with photo-micrography, and I propose now to publish month by month a progressive account in plain and untechnical language of the various methods of preparing objects for the microscope, keeping as far as possible to general methods and to a clear explanation of principles. I trust this will be of service to many readers who have not access to the many excellent books upon the subject, or who find a difficulty in understanding these principles, or in carrying them out. The preparation of objects for the microscope is now a science in itself, and one upon which depends, perhaps, more than any other, the knowledge which we can add to our own or to the common stock by means of that wonderful instrument of precision, the modern microscope.

To begin, then, without further preface. The examination of unprepared opaque objects, such as the seizing of a fly from a window and the imprisoning of it in a life box, or the gibbeting of it in that once popular instrument, a "stage forceps," is only suitable for simple hand magnifying lenses, unless study of some special minute detail be required with a somewhat higher magnification. Of course, there are many beautiful opaque objects, but their preparation is comparatively easy, and may be deferred for the present. The beginner very soon recognises that to place any object at random upon the stage of the microscope, and to focus his highest power upon it, leads only to disappointment and disillusion, and that what is wanted is some means of passing light *through* the object from below. He sees at once that the object is too thick and too opaque, and he realises that the mirror and the condenser would have great uses if only he could get a thin section of the object, could make that section transparent, and, perhaps, could stain it so as to differentiate and contrast its parts.

Now, making sections is the most difficult art of all, though not the least interesting; but it happens to be that one which the beginner least needs at the outset, so we can safely postpone it also for the present. Many of his objects can be exhibited in a drop of water upon a slide, covered with a thin cover-glass, but he soon learns that a hair under such circumstances, or a leaf, still show a disappointing absence of structure. Suppose him to strip the thinnest possible layer of cuticle from the leaf, and to become interested in the exquisite beauty of its structure and of its adaptation, the uniform cellular arrangement, the grains of chlorophyll, the stomata, &c., he will then wish to make a permanent preparation, but may be uncertain how to set about it.

Let us deal first, therefore, with mounting media. These are mainly of two kinds—aqueous media and resinous media. The former are comparatively simple and straightforward, but are seldom suitable for permanent mounts, the latter are excellent, but require care, some trouble, and a little knowledge. Amongst the aqueous media we may place the most useful of all, namely, those into which glycerine enters, which is miscible in all proportions with water, and in which, therefore, sections may be mounted which contain water; whilst in resinous media, of which Canada balsam is the most universally used, water must be rigidly eschewed. It is the neglect of this latter principle, or its careless observance in the various prior processes, which is responsible for so many failures in mounting in Canada balsam.

(*To be continued.*)

Royal Microscopical Society.

March 20.—Dr. J. W. H. Eyre, F.R.S. (Ed.), Vice-President in the chair. The Curator exhibited and described an old solar microscope by Nairne, presented to the Society by Mr. F. R. T. Lucas. Mr. Rousselet read a paper by Mr. Jas. Murray on "Some South African Tardigrada," from various parts of Cape Colony, including eight hitherto unknown species. The author gave detailed descriptions of the species found, and drawings and mounted specimens were exhibited. Dr. Hebb read a paper by Mr. A. D. Hardy, F.L.S., F.R.M.S., of Melbourne, entitled "Notes on a peculiar habitat of a Chlorophyte, *Myxonema tenue*." It is found in rapidly flowing water, frequently attached to sub-

merged parts of river-side plants, but more often to stones and dead twigs, and also in stone-paved gutters in which there is a rapid flow of water. The author also found it growing feebly in a small nearly stagnant fish pond, and luxuriantly on some gold-fish in the pond, so that by the movement of the fish in stagnant water the necessary water friction was obtained for this stream-loving Myxonema. The effect of this algal growth on the fishes was to soon kill them. Mr. A. E. Hilton exhibited under microscopes a large number of mounted specimens of British Mycetozoa, and gave an account of the life-history of these organisms, with illustrations on the board. He pointed out that though formerly classed amongst the fungi, their life-cycle is essentially different, for while in the sporangial stage they resemble fungi, they are distinct in their subsequent amœboid and plasmodial stages, the latter being the distinctive stage which differentiates them from all other groups. In reference to a remark by Mr. Hilton, Dr. D. H. Scott pointed out that the statement as to the existence of fossil Mycetozoa was made by the late B. Renault. The evidence, however, appeared insufficient to demonstrate the presence of the organisms, for though there was no reason why the sporangia should not be preserved, the plasmodium to which the statement referred, was a body one could scarcely expect to identify in petrified material. The question of possible fusion of nuclei, referred to by Mr. Hilton, was of great importance. Mr. F. D. Ersser exhibited a slide of *Trypanosoma Gambiense*.

Quekett Microscopical Club.

March 15.—Mr. James Murray contributed a paper on the Tardigrada. A brief review of the scanty literature of the subject was given, from the first reference to a water-bear by Goeze in 1773, and a mention of Doyère's fine work in 1840, down to Richter's work in 1900. A list of characters to be noted in the two commonest genera, *Macrobiotus* and *Echiniscus*, was followed by special recommendation to intending workers to study the egg. The author then dealt with such practical points as how and where to find water-bears, and how to examine them when found. A description of the general form and characteristics of the group was given and their powers of reviving after long desiccation and of withstanding asphyxiation were noted. Water-bears are found all over the world, and some species are common to the two polar regions and all the continents. The paper concluded with an account of the six different genera at present recognised. Mr. D. J. Scourfield, F.Z.S., F.R.M.S., read a paper on two species of Cladocera new to Britain. These were *Alona weltneri*, Keithack, taken in 1895 by Dr. T. Scott at Scarborough, and *Pleuroxus denticulatus*, Birge, found by the author at Exminster in 1905.

Microbe of Whooping Cough.

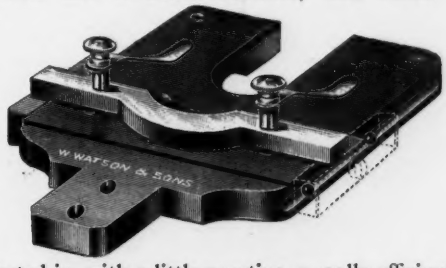
In the Annals of the Pasteur Institute, J. Bordet and O. Gengou, by means of their special blood agar medium, claim to have isolated from the expectoration of early cases of whooping cough a small ovoid bacillus, much resembling the influenza bacillus, but staining more deeply, and not staining by Gram's method. The organism, however, unlike the influenza bacillus, cannot develop on ordinary media, and has much less tendency to produce involution forms. The authors state that serum tests demonstrated the specific nature of the bacillus, and confirmed it as being the cause of whooping cough. It may be of service to give here the composition of the medium used by the authors: 100 grm. of sliced potato is added to 200 c.cm. of 4 per cent. glycerine water, and a glycerine extract of potato obtained by boiling in an autoclave. To 50 c.cm. of this extract 150 c.cm. of normal salt solution (.6 per cent.) and 5 grm. of agar are added. After melting in the autoclave, about 2 to 3 c.cm. of the potato agar is distributed into test tubes, and sterilised. Rabbit's blood (though human is preferable), obtained aseptically, is then defibrinated, and to each tube, the agar being previously melted, an equal quantity of blood is added. The tubes are well shaken, and cooled on the slant. As this medium is free from peptone, it is not suitable for the cultivation of pretrefactive bacteria.

Physiology of Diatoms.

The Journal of the Royal Microscopical Society gives a summary of some experiments by O. Richter on the physiology of diatoms. Some years ago he discovered a method of ensuring pure cultures of these organisms, and he is, therefore, able to be sure of his facts. He finds that *Nitzschia palea* cannot line without silicic acid in the form of $CaSi_2O_5$ or $K_2Si_2O_5$. It is probable that calcium is also necessary at least when SiO_2 is offered in the form of $K_2Si_2O_5$. *Navicula minuscula* has a still stronger need for chalk, while magnesium is another necessary ingredient in the food material of both species. Both are able to assimilate organic compounds of nitrogen, most easily asparagin and leucin, whereas in a free state nitrogen is useless to them. On the whole, diatoms need a weak alkaline reaction. The effect of other compounds is given, as well as the result of experiments in the degree of light and darkness most favourable to growth. The two species were found to be positively phototactic.

Watson's Ball Bearing Sliding Bar.

A mechanical stage to the microscope, though a great convenience, and at times even a necessity, has the disadvantage of not training the fingers to that delicacy of touch and of adjustment which is so necessary a part of the equipment of the worker. The ordinary springs have, however, many drawbacks, and perhaps the most useful and convenient method, other than the full mechanical stage, is what is known as a "sliding bar," which gives a means of most delicate adjustment in truly horizontal and vertical directions, and which when



graduated is, with a little practice, a really efficient substitute for the expensive mechanical stage, and one, moreover, which does not show signs of wear. The sole drawback is a tendency, unless most accurately fitted, for the bar to stick in places, especially when adjusted with one hand only. Messrs. W. Watson and Sons have overcome this difficulty by fitting ball-bearings to the grooves at each side of the stage, which are kept in place by a light spring pressing on the back. By this means a beautifully soft movement is obtained.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

The Face of the Sky for May.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.36 and sets at 7.19; on the 31st he rises at 3.53 and sets at 8.3.

Sunspots and faculæ may usually be seen on the solar disc; prominences, too, may be expected to be fairly conspicuous on spectroscopic examination of the limb.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 1 ..	24° 23′W.	4° 6′	356° 13′
,, 6 ..	23° 25′W	3° 35′	290° 8′
,, 11 ..	24° 17′W	3° 2′	224° 1′
,, 16 ..	20° 58′W	2° 28′	157° 53′
,, 21 ..	19° 30′W	1° 54′	91° 45′
,, 26 ..	17° 52′W	1° 18′	25° 36′
,, 31 ..	16° 6′W	0° 42′	319° 26′

THE MOON:—

Date.	Phases.	H. M.
May 4 ..	☾ Last Quarter	9 54 p.m.
,, 12 ..	● New Moon	8 59 a.m.
,, 20 ..	☽ First Quarter	1 28 p.m.
,, 27 ..	○ Full Moon	2 18 p.m.
May 16 ..	Apogee	9 12 a.m.
,, 28 ..	Perigee	5 18 p.m.

OCCULTATIONS.—The double star ν Sagittarii is the only naked eye star occulted before midnight during the month. The occultation takes place on the 29th, ν^1 disappearing at 10.46 p.m. and ν^2 at 11.5 p.m.

THE PLANETS.—Mercury (May 1, R.A. $1^h\ 10^m$; Dec. N. 4° 35′; May 31, R.A. $5^h\ 5^m$; Dec. N. 24° 21′) is a morning star in Aries rising only a short time before the Sun during the early part of the month, and therefore practically unobservable. On the 24th the planet is in superior conjunction with the Sun; after this date the planet is an evening star in Taurus, setting at 8.57 p.m. on the 31st.

Venus (May 1, R.A. $0^h\ 20^m$; Dec. N. 0° 24′; May 31, R.A. $2^h\ 35^m$; Dec. N. 13° 26′) is a morning star in Pisces, rising at 3.16 a.m. on the 15th, or about one hour before the Sun. The planet is diminishing in brightness and presents a gibbous appearance in the telescope, 0·84 of the disc being illuminated.

Mars (May 1, R.A. $18^h\ 54^m$; Dec. S. 23° 58′; May 31, R.A. $19^h\ 23^m$; Dec. S. 24° 54′) rises at midnight on the 14th, and is on the meridian at daybreak. The planet is situated in Sagittarius, and may be observed in the early hours of the morning looking S.E. shining as a moderately bright reddish star.

Jupiter (May 1, R.A. $6^h\ 31^m$; Dec. N. 23° 24′; May 31, R.A. $6^h\ 55^m$; Dec. N. 23° 2′) is still a conspicuous object in the evening sky looking West at sunset, and is now moving away from the position which it has occupied near η and μ Geminorum these few months past.

On the 5th the planet sets at midnight, and on the 31st at 10.36 p.m.

The Moon will appear near the planet on the evening of the 16th. The apparent diameter of the planet continues to diminish as the distance from the earth increases; the equatorial diameter on the 16th being 33″·1, and the polar diameter 2″·1 smaller.

The following table gives the satellite phenomena observable in this country:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
May				May				May			
1	I.	Tr. I.	8 23	8	I.	Tr. I.	10 22	17	I.	Tr. E.	9 10
	I.	Sh. I.	9 28	9	III.	Sh. E.	10 15		I.	Sh. E.	10 6
	I.	Tr. E.	10 41	10	II.	Tr. I.	10 34	21	IV.	Oc. D.	9 22
2	I.	Ec. R.	9 4	12	II.	Ec. R.	9 39	24	I.	Sh. I.	9 42
3	II.	Sh. I.	9 58	16	I.	Oc. D.	9 43	25	I.	Ec. R.	9 19
	II.	Tr. E.	10 39								

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (May 1, R.A. $23^h\ 40^m$; Dec. S. 4° 16′; May 31, R.A. $23^h\ 49^m$; Dec. S. 3° 24′) is a morning star in Pisces, rising at 2.30 a.m. on the 16th. The ring appears closed, the plane of the ring passing through the Sun, hence the telescope appearance is merely that of a straight line, similar to that shown below at the periods 1891 and 1907.

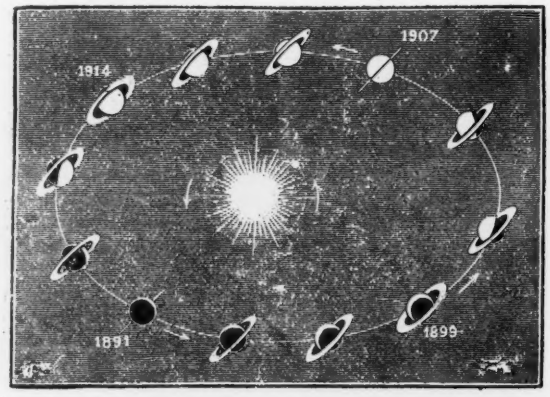


Diagram showing the Variations in the Appearance of Ring in Different Years.

Uranus (May 16, R.A. $18^h\ 54^m$; Dec. S. 23° 14′) rises about 11.30 p.m. near the middle of the month. The planet is not well placed for observation, as he is situated low down in Sagittarius.

Neptune (May 16, R.A. $6^h\ 46^m$; Dec. N. 22° 11′) is observable in the North-West portion of the evening sky; on the 15th the planet sets about 11.20 p.m.

METEOR SHOWERS:—

The principal shower during May is the *Aquarids*. This may be looked for between May 1 to 6; the radiant being in R.A. $22^h\ 32^m$ Dec. S. 2°, near the star η Aquarii.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—α Libræ, XIV.^{h} 46^m, S. 15° 39′, mags. 3, 6; separation 230″; very wide pair.

σ Coronæ, XVI.^{h} 11^m, N. 34° 8′, mags. 6, 6½; separation 4″·8; binary.

α Herculis, XVII.^{h} 10^m, N. 14° 30′, mags. 2½, 6; separation 4″·6. Very pretty double, with good contrast of colours, the brighter component being orange, the other blue.

δ Herculis, XVII.^{h} 11^m, N. 24° 57′, mags. 3, 8; separation 14″.

CLUSTERS.—M13 (cluster in Hercules) is situated about one-third the distance from η to ζ Herculis, and is just visible to the naked eye. It is a globular cluster, and with a 3 or 4 inch telescope the outlying parts of the cluster can be resolved into a conglomeration of stars.